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# THE WINTER STATE OF OUR DUCKWEEDS.

BY PROF. T. D. BISCOE.

IN the autumn of 1871, I brought home a bottle full of duckweed (*Lemna polyrrhiza*) and emptied it into a tumbler of water with a mass of algæ gathered at the same time.

Within a few days the Lemnæ all turned white and died, and the fronds seemed to decay. I kept the algæ in the tumbler all winter, adding fresh water as fast as it was diminished by evaporation. I saw no more of the duckweed till the last of the winter, when one day, to my great surprise, there appeared floating on the water a group of fronds that were certainly Lemnæ, and a few days after I noticed another frond. What had they grown rom? I turned out the water into a basin and found about fifty little disks which seemed to answer the description of autumnal or winter fronds as described in my "Gray."

My curiosity was excited. How could such things grow into Lemnæ? Where was the growing point? Where were the roots to start from? What was the internal structure of these regular little disks? Should I find anything corresponding to buds about them?

Some of these queries I have answered and others are still unsolved.

I propose to give a short account of my failures and successes, and of the methods of investigation by which I tried to reach the knowledge sought; and hope that my trials may be of service to

some who often desire to make additions to the store of botanical morphology but who hardly know how to proceed.

It is best to select some definite question concerning the case that one wants to study, and then with knife, needles, chemicals and microscope, compel it to yield an answer. It will give definiteness and precision to one's work. I started with this one: "Where is the growing-point of this winter frond?"

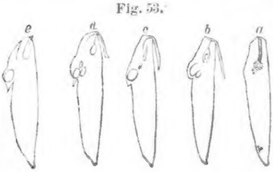
By Figs. 1 and 2, it will be seen that the object is almost exactly of the shape of a shallow plano-convex lens, the flat side being the upper side; as I found some weeks after, when they rose and floated on the surface of the water.

The outline is often slightly kidney-shaped, and at the sinus there is a scar on the edge, Fig. 2*s*. Sections show that the edge is here more obtuse than elsewhere.

Around that point, on the flat surface, there was traced a small semicircle. That was all that could be descried on the exterior. The disk was not at all transparent, so that all knowledge of its interior must be obtained by dissection.

Laying the frond on the end of the forefinger, and holding it in place by a gentle pressure of the thumb, I made three or four slices lengthwise (that is in the direction of the lines *a–a*, *b–b*, etc., of Fig. 2). From the tip three-quarters of the way to the base (as I shall call the scar end) all these sections were composed of simple parenchymous tissue (where cells are of nearly equal dimensions in all directions), whose cells were packed with starch grains. But the quarter next to the base presented very different views in the several sections, and appeared quite complex (Fig. 53). Two regions, Fig. 4 *a* and *b*, attracted attention because of the fineness of the tissue composing them. The cells in these parts were not more than an eighth the diameter of the regular cells of the frond; neither were they filled with starch grains, but were well supplied with protoplasm, with considerable chlorophyl.

Fig. 53.




Here evidently was the place to search for my "growing-point." In that one of these regions furthest from the base, Fig. 4 *a*, and on the convex or under side of the frond, are one, two, or more oval bodies whose axes of growth were nearly at right angles to the length of the frond. I took them for young buds. In each section

one was larger than the rest. I took it for the main bud, and supposed that its extremity was the growing point of the plant. To get a better view of its tip, that I might make out the plan of cell-division at the point where the cells were first formed, I made some new sections in the same direction, much thinner than the first. On examining these I recognized the cell arrangement peculiar to the extremity of roots; there plainly enough was the root-cap, Fig. 4 *d*, and the "summit" cells or region, Fig. 4 *c*, where by cell-division the new growth is produced. These were surely the rudiments of young roots. I must look elsewhere for the plumule with its growing point. But one thing had been learned; my little disk contained roots, and I knew where they were.

The other spot where the cells were small and tinged with green seemed without any regular shape. One section showed one thing, another quite a different thing; while in another there would be nothing but a hole where the fine cells ought to be.

See the differences in the five sections of Fig. 53. These sections were made through the lines marked *a-a*, *b-b*, etc., of Fig. 2.

As the next step I made some sections at right angles to the former in the directions A–A, B–B, etc., of Fig. 2 (see Fig. 5), and got one new idea at least. Instead of there being one body in the place occupied by "*b*," Fig. 4, there were two, one on either side of the median line of the frond, and the two were very unequal in size, though somewhat similar in form. But, although diligently comparing the views presented by the two sets of sections, I could not form any satisfactory idea of these portions. The two sections D and E, of Fig. 5, showed quite clearly the number and position of the young roots. The darker spot which appeared in the last three sections, marked "*s*" in "D," Fig. 5, was a new mystery. I must have sections in the third plane also, that is, the plane passing parallel with the surface of the frond.

And just here let me say a word about making sections of delicate vegetable tissue. I have found it much better in all cases, except where the position and structure of the protoplasm are in question, to soak the specimens in glycerine, first in diluted and finally in strong. One advantage is this; when making sections of soft tissues in water, there is great danger that a thin section on the blade of the razor will dry up and be spoiled, while attending to the piece on one's finger, which ought to be taken off immediately and laid in water. Or if one first cares for the section on the

razor, then the piece from which it is cut may be spoiled. But when the object is in glycerine, plenty of time can be taken to care for both without any injury coming to either. I have found a good razor the very best thing to cut with, much better than any lancet or small dissecting knife.

Let the thumb-nail of the left hand be cut short enough that the blade of the razor may rest against the flesh of the end of the thumb, while the object to be cut rests on the forefinger and is held in place by the thumb. You can then draw the razor very evenly, it being steadied by the thumb. The thickness of the slice can be regulated by pressing the razor less or more against the yielding flesh of the thumb. Especially is this the case when several sections are made one after the other by as many drawings of the razor, each time pressing it a little more against the thumb-end. In this style of cutting, the hand should be so held that the surface of the forefinger, on which the object is laid, should be horizontal; but when a thin object is to be split parallel with its surface, I have found it best to turn the hand, after the object has been placed, as before, between the forefinger and thumb, so that the surface of the finger on which the object is lying should be vertical: you see then the edge of the object to be split. The edge of the razor must, of course, be also a vertical iine. It is essential, in this case, that the object be placed far enough back from the ends of the finger and thumb that the razor blade may come between them and be guided and steadied by its contact with them.

Having brought the edge of the razor in contact with the object to be split, draw the razor downward, bringing at the same time the heel outward (towards the right) and the point inward, making the part resting between the thumb and finger the centre of this slight rotation.

During this operation I have found it best so to hold the hands and head that the eye sights right down the edge of the vertically held razor, for then the razor edge can be placed very truly against the exact portion of the object to be split that you desire.

Resuming now our investigation of the duckweed; — I sliced the frond into three or four sections parallel with its surface, and, placing them under the microscope, order seemed to be emerging out of chaos. To the right and left of the middle line of the frond were two cavities, one of them almost filled with one of the small celled bodies, Fig. 6 *rb*, while the other was not more than one-

third filled, Fig. 6 *lb*. The middle line, Fig. 6 *st*, was distinguished from the rest of the frond by the shape of the cells composing it, and also by the fact that they were empty. At one end was the scar, Fig. 6 *sc*, and at the other a snarl of cells out of which radiated five or six veins or ribs, Fig. 6 *v*, consisting of woody fibre with spiral cells; besides, there was a single line of spiral cells turning back into each of the two small-celled bodies. This centre of radiation was what I had seen in the sections of Fig. 5, marked "*s*." This middle portion is the stem of the frond, and the scar marks the place where it separated from its parent frond.

I began then to understand the other appearances; these were the young buds by which Lemna propagates itself independently of seeds. Each one of these would grow into a complete individual, and in it I must look for the "growing-point."

The cavity in which the larger bud grew seemed of a rectangular form, with rounded corners from the lower of which the bud stalk started: the bud itself partook somewhat of the same rectangular shape, instead of being circular, as most of the fronds were.

The young bud on the right, though as yet without any ribs of woody fibre, showed plainly where they were to be, for in the lines that they were to occupy the cells were compact, with no intercellular spaces, while in the rest of the bud between these rudimentary ribs the cells had parted at the corners and produced air spaces, small indeed, but yet sufficient to give a marked character to that portion of the tissue. The part next to the stem of the bud was, like the ribs, without intercellular spaces.

The axes of the frond and buds are at an angle with each other of about 45°, or more correctly 135°, since the normal position of a branch is in nearly the same direction as the stem, and its divergence should be measured round from that direction as its starting point. With our plant the line of growth seems to be backward. If the same law holds in regard to the buds of the next generation then they must be sought near the stem and with their axes inclined at the same angle. (See the diagram, Fig. 9, where the vertical line represents the axis of the frond, and the different oblique lines the axes of the buds.)

A little examination showed that it was so, and that on each side of the axis of the bud, and near the base, was a little protuberance which was evidently a bud of the next generation. But, though they were there, it was by no means so clear what their form might

be, or how far they had advanced in laying the rudiments of the organs possessed by the mature frond. Here began the difficulties of the investigation. My desire was to trace back the frond to the stage in which it was represented by a single cell, or at least by a small group of homogeneous cells, on which there was no sign of any organ; and then to be able to see both where and in what shape each new part was produced by changes in the growing point and the tissue adjacent thereto.

Of the two budlets, the one on the left, next to the main stem, was the most developed, and I studied it, rather than the other. Figs. 6 and 14 present the views obtained when the razor just grazes the upper surface of the buds. Near the upper edge of the bud was a most delicate line, Fig. 6 *m*, which could hardly be traced with a $\frac{1}{4}$ inch objective. A $\frac{1}{8}$ objective and $\frac{1}{14}$ objective showed that it was the edge of a membrane consisting only of one layer of cells in thickness. The cells, Fig. 55, were irregularly shaped and had crinkled walls. I could follow the line most to the edges of the bud, but not quite. The budlet, Fig. 14, was, like the bud, of a rectangular outline nearly, and grew out from the corner of its cavity. I could make out the following particulars; "*a*" a fine curved line which it took close observation to see at all; "*d*" a double line at the back of the budlet; "*c*" and "*e*" two swellings of the outline of the budlet "*b;*" "*f*" an edge of tissue two cells thick coming to a point where it reached the frond at "*i;*" "*h*" the least developed budlet; and "*g*" a small protuberance of cells, which I have not thoroughly studied and shall therefore be obliged to omit in my descriptions. What it may grow into, if it grow at all, I cannot say.

Horizontal sections had helped greatly, but vertical sections seemed now to offer the only hope of increasing my knowledge of the bud and budlet. After making many, I was no better off, because it was impossible to tell exactly in what direction, as regards the axis of the bud, the sections went. I then split a frond through so as to reveal the upper surface of the bud without touching it with the razor or loosening it from its attachment.

Then with the camera I sketched its outline as seen with a $\frac{1}{4}$ and was then ready for the delicate work of slicing it up. (Fig. 7 gives such an outline.) Taking the frond on the forefinger I cut one section as nearly as possible in the direction which I had decided would give a longitudinal section of the bud, as Fig. 7 *e-e*.

As soon as the cut was made the piece taken off was laid on a slide in a drop of glycerine, and the slide numbered "No 1." Next the frond, from which the cut had been made, was put under the microscope and the direction and position of the cut observed and its place recorded on the camera drawing, and numbered "1." The frond was then laid on the finger and the second cut made, as thin as possible, and as near parallel to the first as might be. I could not succeed in getting the series of cuts as nearly parallel to one another in this way, as by cutting all the sections at once without removing the razor from its rest against the end of my thumb. But generally the deviations from parallelism were not so great as to interfere seriously with the usefulness of the sections, considered as a set.

After each cut, the section was placed on its separate slide and numbered and the remainder of the frond placed under the microscope and the position of the cut marked. In this way I sometimes got a series of fifteen or twenty sections, extending from one edge of the bud to the other. Of these from three to five would pass through the budlet.

Next was the study of these sections one after the other in order, comparing them with each other, and with the surface view of an uncut bud, attempting to construct mentally the complete form of which the microscope gave me successive sectional views. I had had before just as good sections, in some cases better ones, but then could not tell from what part they came and so had been unable to form a connected satisfactory idea, or model, of the whole. One such set shed light in a given direction, but others were needed. Some eight sets of vertical sections in various directions gave all that could be expected of them, and yet the matter was not quite clear. I wanted the budlet sliced in a direction parallel with its surface. The plane of the bud is not quite parallel with that of the frond, so that I could not get just the right sections by the method of splitting the frond between the thumb and forefinger. I could imbed a frond in a mixture of gum and glycerine; but that took so long to harden that, if several fronds were prepared for cutting, I was very apt to forget just where the cut should be made in each, and so run the risk of spoiling the specimen. Something was wanted that would set and harden in a few minutes. I thought of collodion, and on trial it proved to be just what was wanted. When the specimens are saturated with glycerine, and

placed on the end of a little stick of pith, I drop a single drop of collodion over them, which hardens in about two minutes, and without sticking to the specimen makes a complete socket for it. From fronds mounted in this way I succeeded in getting sections so thin that it took three of them to make up the thickness of the budlet.

In order to test the correctness of the opinions formed from the comparison of these different sectional views, I wanted next to dissect out a budlet free from the bud, and in an uninjured state, and turn it over and over while in the field of view of the microscope. I have accustomed myself to the use of dissecting needles under the compound microscope without the help of an erector, and so was able to have the advantage which the binocular gives for such work.

I should advise, from my experience, that any one using a binocular, who has much occasion for dissecting, should learn to handle the needles under the microscope without an erector. It is not difficult to train one hand, though when it comes to using both I acknowledge that one will need a good stock of patience.

The powers used for this work were 80 and 115 diameters. The needles found most useful were those which had been ground with an exceedingly slender taper and the shortest possible piece of the tip bent at an angle of about 45°.

The budlet when obtained free measured about $\frac{3}{1000}$ of an inch in length and half that in breadth and thickness. To observe it to advantage one must use powers of $\frac{1}{4}$ and upwards.

Having placed it in a drop of glycerine, cover with a rather large cover, and let there be enough of the fluid to prevent the cover's pressing it on the slide; then with a needle gently push the cover in one direction or another till you have your object rolling over and over fast or slow just as desired.

Now let us gather up the facts we have obtained by the methods described. Figs. 10, 11, 12, and 13, give specimen sections taken in as many different directions through the bud as shown on the plan, Fig. 7.

The dotted lines in the bud of Fig. 7, show what would be seen when the lower surface of the bud is focussed instead of the upper. I drew them in the same figure in order that their relation to the upper surface might be plainer than if I had given them a separate drawing. In Fig. 10, we have a section passing parallel with the

stem of the bud, but a little to the left. It crosses both the lines in the upper part of the frond, it goes through one of the dotted oval bodies, and also through the budlet to the left of its stem. The section shows that those lines on the upper part of the bud, Fig. 7 *um*, and *lm*, one above and one below, are the edges of two membranes that nearly enclose the bud between them, the one on the upper surface only one layer of cells, the lower several layers thick.

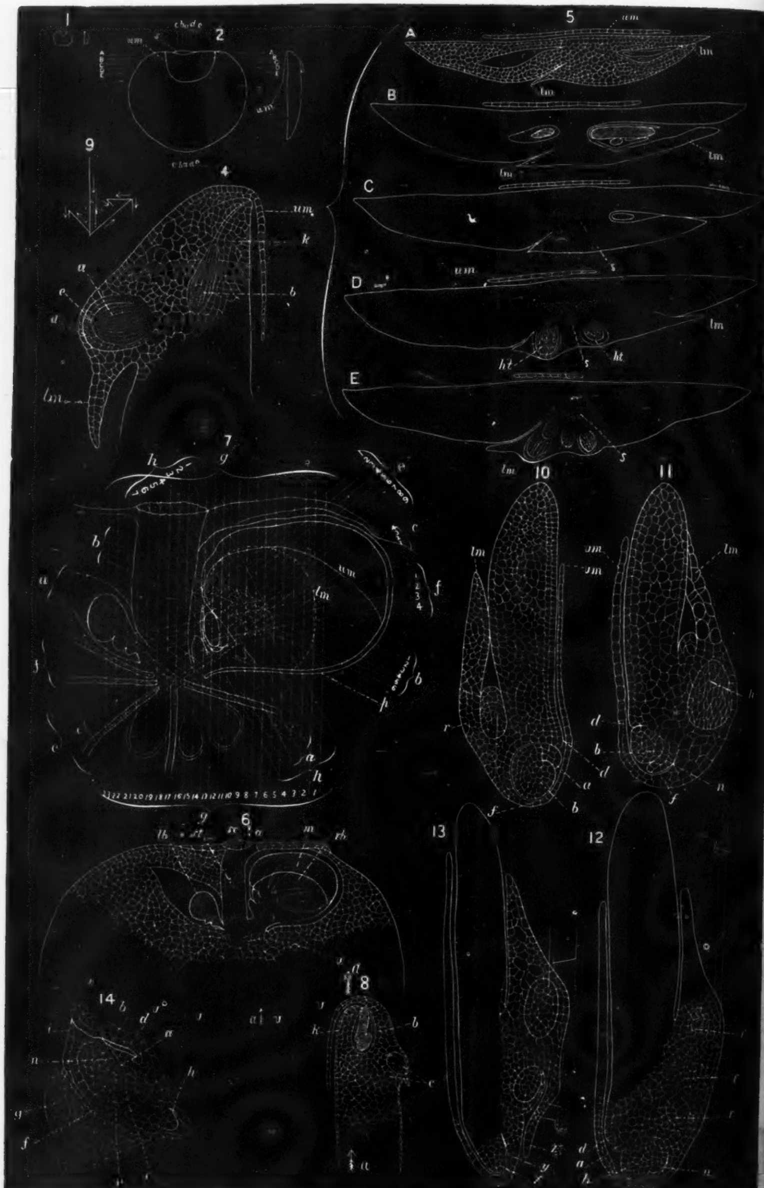
The oval body of Fig. 7 is here seen in the angle between the lower membrane and the body of the bud. It shows itself to be the beginning of a root. The swelling "*d*," Fig. 10, is the section of that projection of the body of the bud over the budlet whose edge shows in Fig. 14 as the double line "*d*." As this projection grows more and more, it shuts over the budlet, reaching down as far as the point "*f*," Fig. 10, and becomes in the frond the lip or cover "*k*," Figs. 4 and 8. The line "*a*," Fig. 14, is shown "*a*," Fig. 10, to be the edge of a ridge starting out from the budlet which as it grows will become the membrane "*um*" of the bud. The section shows us the thickness of the budlet "*b*," and explains that the double row of cells "*f*," Fig. 14, just below the budlet is the optical section of the upper membrane where it bends round to its attachment on the under side of the bud. One cannot help recognizing in the "*um*" of the bud, Fig. 10, the "*um*" of the frond, Fig. 4, which shows itself as the semicircle of Fig. 2.

Turning next to Fig. 11, which also passes through the budlet, but nearer to its stem, and at an angle with the stem of the bud, we find two or three new features. First; we pass through the right hand one of the three oval bodies of Fig. 7, and find it imbedded in the base of the lower membrane, instead of occupying the angle; second, the budlet has a thick horn "*n*" on its under side, and none on its upper. The outline of this membrane is, I think, that indicated by the dotted line, Fig. 14, "*n*," on the budlet, but I have not been able to satisfy myself just where that outline does run. Again, in this section, we see the budlet united with the bud, whereas before, the section, Fig. 10, passed out to the left of the stem and showed that, by lying entirely separate from the bud. Fig. 12, which shows a section nearly parallel with the axis of the budlet, gives a view of both horns "*a*" and "*n*" at once, and showing one root, allows the others $r'$ and $r''$ to shimmer through the tissue, though out of the focus.

Fig. 13 shows the three roots at once, though with the middle one out of focus. The left hand part of this section is a puzzle to me that I am not sure I have rightly solved. Till I came to it I did not suppose there was any membrane on the lower side like "*z*." In every other section, out of forty, perhaps, that ran through that neighborhood, there was no projection of the lower membrane toward the left, but the tissue passed continuously from the roots round into the base of the upper membrane, as in Figs. 10, 11, 12. I think there may be a narrow lappet or lobe of the lower membrane at just this part, while below the tissue may be as in the other sections. I do not think that the part marked "*x*" is part of the budlet, but of the bud.

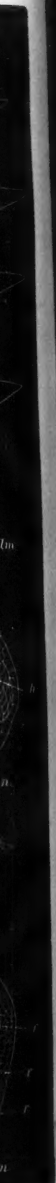
Now to take one step more: has the budlet the beginning of a budlet of the next generation? Yes, at the point "*e*," Fig. 14, there is a slight protuberance just about where the upper membrane "*a*," Fig. 14, comes to the edge of the budlet. And this is what will grow into first the budlet, then the bud, and finally the frond.

When the budlet was dissected out and examined with a $\frac{1}{14}$ (Hartnack's No. 10), the protuberance showed nothing but a group of half a dozen to a dozen cells all alike with no sign of any organ of any sort. This then was the growing point which I set out to find. Now how are the different parts of the frond produced from it? As the first stage we have the budlet: it differs from the growing point only in this that a ridge or lappet has been formed on the upper and under surface, which in the sections shows as two horns as "*a*" and "*n*," Fig. 12. These two ridges are really one continuous ridge as I could see when rolling a free budlet over and over. It can be traced from "*e*," Fig. 14, in a slanting curved line to the back of the budlet near its tip, then down the thickness of the budlet till it joins the ridge of the under side. As our next step, we see in the bud our ridge grown into those two membranes (as we have called them) which a careful examination shows to be still continuous at the back edge of the bud about as far out as the point "*p*," Fig. 7. Also three roots, Figs. 7, 10, 11, 12, have made their appearance near and in the base of the lower part of the membrane. Also the tissue of the bud is preparing for the five or six veins that the frond is to possess, and the stem possesses a single fibre of spiral cells. Now, lastly, what more do we find in the frond? The edge "*d*," of Figs. 14 and 10, has grown



ANATOMY OF WINTER BUDS OF LEMNA.

3.



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out over the budlet; and, as the section, Fig. 4, shows, forms the cover "*k*" of the cavity in which the bud "*b*," Fig. 4, lies. The body of the bud, having grown much faster than the membrane, has left the latter as the semicircle seen at the base in Fig. 2. The same thing is true of the lower membrane which now only forms a border to the enlarged roots.

The books speak of Lemna as a plant entirely destitute of leaves, but it seems to me that an exception must be made in the case before us, for this membrane on the upper and under sides

Fig. 54.

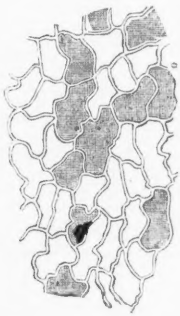
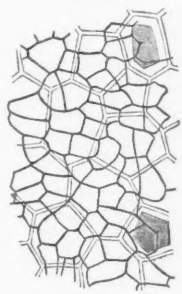


Fig. 55.

Fig. 56.



seems to answer in its position and formation to the sheathing leaves of the monocotyledons.

I noticed the peculiar form of the cells of the semicircular lobe of the leaf (?) on the upper side of the frond, and made a drawing of them, Fig. 54, and also a drawing of the same organ in the bud state, Fig. 55. It was this peculiar form of cell in the two cases which first led me to think that they were the same thing in different stages of growth. In Fig. 56 I have presented a surface view of the epidermis of the frond, together with the underlying cells of the frond. Two of the latter cells are nearly filled with a large crystal in each. What is the cause of the brown color of some of the cells of the upper lobe of the leaf as shown in Fig. 54, while others are clear, I cannot tell.

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## EXPLANATION OF PLATE.

**Fig. 1.** Winter frond, natural size; surface and profile views.

Fig. 2. Same, enlarged about 10 times. The lines, *a-a*, *b-b*, indicate the direction of the sections of Fig. 53, and those marked A-A, B-B, those of Fig. 5; "*s*" is the scar where the frond was attached to its parent; "*um*" the outline of the upper membrane (drawn with 2 inch objective, 2 inch ocular, distance from camera to paper, 5 inches).

Fig. 53. In text, longitudinal vertical sections, as marked in Fig. 2 (objective 2 in., ocular 2 in., distance 5 in.).

Fig. 4. Section in the direction *e-e*, of Fig. 2: "*a*" young root; "*c*" its "summit region;" "*d*" its root-cap; "*b*" young bud; "*k*" lip or cover to the same; "*um*" upper membrane; "*lm*" lower membrane (objective ⅝ in., ocular 2 in., distance 10 in.).

Fig. 5. Sections in the directions A-A, B-B, etc., of Fig. 2: "*s*" of C, D, and E, end of stem; "*rt*" roots; "*lm*" and "*um*" same as Fig. 4 (objective ⅝ in., ocular 2 in., distance 5).

Fig. 6. Horizontal section in the direction of the arrows *a-a* of Fig. 8: "*rb*" the right hand bud or most developed; "*lb*" left hand bud; "*st*" the stem or axis; "*sc*" scar; "*v*" the veins or ribs of the frond; the arrows "*a-a*" show direction of the section of Fig. 8 (objective ⅝, ocular 2, distance 5).

Fig. 7. Outline plan of buds, with lines showing where different sections were made (objective ⅝, ocular 2, distance 10).

Fig. 8. Section through *a-a*, of Fig. 6. "*b*" bud: "*c*" roots. "K" same as *k*, Fig. 4 (objective ⅝, ocular 2, distance 5).

Fig. 9. Diagram of the directions of the axes of growth of the different generations.

Fig. 10. Vertical section of the bud in the position and direction marked by "*e-e*, 5, Fig. 7." "*r*" root; "*f*" base of "*um*;" "*b*" budlet; "*a*" ridge of budlet, or rudiment of the upper membrane; "*d*" rudiment of lip or cover of bud cavity; "*lm*" and "*um*" as before. The lettering and amplification of Figs. 10, 11, 12 and 14, are the same (objective ¼, ocular 2, distance 10).

Fig. 11. Section through "*g-g*, 12, of Fig 7." "*n*" the rudiment of lower membrane.

Fig. 12. Section through "*f-f*, 2 of Fig 7." "*r-r*" "roots below the plane of the rest of the drawing.

Fig. 13. Section through "*b-b*, 5 of Fig. 7." For "*x y z*" see text.

Fig. 14. View of the base of the bud of Fig. 6: "*e*" the growing point or budlet of the next generation; "*h*" corresponds with "*lb*" of Fig. 6; for "*c*" and "*g*" see text.

Fig. 54. In text, surface view of portion of upper membrane of frond (objective ¼ ocular 2, distance 10).

Fig. 55. In text, surface view of the upper membrane of the bud (objective ¼, ocular 2, distance 10).

Fig. 56. In text, epidermis of frond with larger cells of the cellular tissue seen underneath, two of the latter containing crystals (objective ¼, ocular 2, distance 10).

All the drawings are camera lucida work except Fig. 1 and a portion of the cells filling up the sectional views.

# THE INFLUENCE OF INSECT-AGENCY ON THE DISTRIBUTION OF PLANTS.

BY F. BUCHANAN WHITE, M.D.

In urging botanists to study the influence that insect agency has upon the distribution of plants (see vol. x., p. 334), Mr. Bennett

points out a very interesting subject for investigation, and I trust that the readers of the Journal will not lose sight of it.

If *Sphinx Convolvuli* is the chief agent in the fertilization of *Convolvulus sepium*, then the reason why that plant seldom in Britain perfects seed (as is said to be the case) is readily explained. The moth is rare in Britain, and I do not at present remember any record of its having been seen visiting the flowers of *Convolvulus*, though it is generally taken in the act of hovering over flowers, notably *Petunia* and honeysuckle. Though *Sphinx Convolvuli* occurs throughout Britain (even beyond the range of *Convolvulus*, *e.g.* Orkney), yet it is most especially a southern insect, and perhaps that may account *in some measure* for the rarity in a wild state (at least in my experience) of *Convolvulus sepium* in Scotland.

*Dianthœcia* (a genus of night-flying moths) must exert a great influence upon the fertilization (and consequent abundance) of *Silene* and *Lychnis*. In fact, the perpetuation of the race of these moths depends upon the fertilization of the plants, since the larvæ feed only upon the unripe seeds. This is a case somewhat similar to, though by no means so extraordinary as, that mentioned by Professor Riley at the last meeting of the American Association for the Advancement of Science. Professor Riley showed how the fertilization of *Yucca* depended on the agency of a moth, the female of which collects the pollen and places it on the stigma, for the express purpose that the larvæ, produced from the eggs which she deposits on the ovary of the plant, may have a supply of unripe seeds to feed upon. In regard to *Lychnis* and *Silene*, it is possible that if there were no *Dianthœciæ* the plants might be more numerous, since other moths visit the flowers, though the *Dianthœciæ* are the chief visitors. *Silene maritima* is the most frequented species (it is, perhaps, worth remarking that it has also the largest flowers, and is, perhaps, the most numerous in individuals) of course, in proportion to its restricted usually maritime habitat; *Lychnis Flos-cuculi* is more especially visited by *Dianthœcia Cucubali;* and *Silene Otites* a plant of the eastern counties, by *Dianthœcia irregularis*. On the Continent this insect frequents *Gypsophila paniculata*. I know of no insect visitors to *Silene acaulis* and *Lychnis alpestris*. Possibly, if *Lychnis alpestris* had more insect visitors, it might be more abundant on our mountains, though the peculiarities of the locality (in Forfarshire, at least) have doubtless something to do with its restricted range.

It is probable that insects are the agents in the production of the numerous hybrids that occur between species of the genus Carduus, on the flat horizontal top of whose heads various species of Lepidoptera may often be seen. The downy bodies of these moths would readily convey pollen from one plant to another, and, when the plants were different species, hybridization might be the result in a genus the species of which seem so liable to that phenomenon. *Carduus Carolorum*, which is supposed to be a hybrid between *C. palustris* and *C. heterophyllus*, may have been produced by the agency of *Trichius fasciatus* (a beetle belonging to the family *Cetoniadæ*), whose thorax and underside are very shaggy, and which loves to bury its head and shoulders in the head of a thistle. This beetle is rather rare in Britain, but is not uncommon in the district where *Carduus Carolorum* was found.

The species of *Meligethes* (a genus of small beetles) inhabit flowers. M. Brisout, in *L' Abeille* (vol. viii., January, 1872) points out the flowers in which the various species are generally to be found. Among these are *Genista*, *Galium*, *Prunus spinosa*, *Symphytum officinale*, *Mercurialis perennis*, *Trifolium medium*, *Solanum Dulcamara*, *Melilotus*, *Cyanoglossum officinale*, *Lotus* and other *Leguminosæ*, *Lamium album*, *Galeopsis*, *Mentha*, *Marrubium vulgare*, *Nepeta Cataria*, *Ballota nigra*, *Teucrium Scorodonia*, *Salvia*, and other *Labiatæ*. Many species affect only one kind of plant each, and in going from flower to flower cannot fail to carry pollen with them. *Teucrium Scorodonia* is a great favorite with many nocturnal Lepidoptera, and this, perhaps, partly accounts for the great number of individuals of this plant. Moths usually abound in places where the Teucrium grows.

Many flower-frequenting night moths have more or less strongly developed crests of hairs on the thorax. Many flowers frequented by these moths have blossoms with mouths directed to the horizon (*i. e.* neither drooping nor facing the zenith), and stamens more or less exserted and ascending; styles also more or less exserted. When a moth visits such a flower it either hovers in front of it and plunges its haustellum into the corolla, or else rests on the flower and does the same. In either case it brushes the stamens with its thorax, and carries off unwittingly a supply of pollen to the next flower visited. Now, it is worth noting that some of the moths which hover (*e. g.* the *Plusiidæ* * and *Cucullia*) have very strongly

* Have also crested heads.

developed thoracic crests, and that some flowers which are especially favorites with them have long, exserted, ascending stamens and styles (*e. g. Echium vulgare* and *Lonicera Periclymenum*). If the stamens in these plants were short, the pollen would have little chance of being brushed off by the thorax of the moth, and it does not readily adhere (as the sticky pollen masses of the orchids do) to the haustellum, and if the thorax of the moth were smooth the pollen would not be so liable to be brushed off, even though the stamens are exserted; whereas with exserted and ascending stamens in the flower and crested thorax in the moth, we have every condition necessary to insure a greater or less quantity of pollen being conveyed from one plant to another. In the *Labiatæ* the stamens, though so few, seem to be especially arranged in many species, so that every chance may be afforded of pollen being carried. In *Ajuga reptans* and *Teucrium Scorodonia* the stamens are exserted and ascending, and are four in number — two long and two shorter. An insect therefore in plunging its head into the corolla would almost necessarily brush all the four stamens. These plants are much visited by moths.—*Journal of Botany.*

## RELICS OF A HOMESTEAD OF THE STONE AGE.

BY CHARLES C. ABBOTT, M.D.

THE interest that centres in every isolated arrow point or rude stone axe that we chance to come upon, as it is lying in the field — the train of thought that such relics excite in every intelligent observer, absorbing as it is, pales into a commonplace occurrence, when we happen to meet with a series of stone implements of many forms, that epitomize, in their individual and collective characters, the habits, and occupations of their Stone Age owners; and to a far greater extent is this the case, when these collected relics are seen lying in the very spot where their ancient owners left them: the corn-mill and its crushing-stones by the hearth, still black with ashes; the hatchet near by, that was used to split the marrow bones of animals; the polished horn-stone skinning knife, and skin dressers; and back from the fire-place, in separate piles, the battle axe, spears and arrows of each inmate of that household.

In about such positions, each rude relic telling its own story as plainly as ever do the contents of a carefully opened grave, we lately had the good fortune to find a "deposit" of stone implements, numbering in all, about one hundred and seventy specimens.

The discovery of this deposit was made on the removal of the brow or face of a low bluff, and filling up of a shallow valley, that a more level road might be run through the property. A little brook, almost dry in summer, rippled through the valley; which stream was no doubt of much greater volume when the aborigines dwelt upon its banks.

The relics of this "find" were met with in a circumscribed spot of about thirty feet in diameter, and some twenty inches below the surface of the ground. The floor of this "homestead," as we have called it, was very hard and compact; the soil being of a darker color than the superincumbent earth, and well mixed with small oval gravel stones, of a noticeably uniform size. At one side of the nearly circular spot was a well defined fire-place, marked by a circle of oval white stones, six to eight inches in length, and half that in thickness. Within this circle was a layer of ashes and charcoal, seven inches deep in the centre, and three at the margin of the fire-place. This coal and ash deposit showed, on careful examination, a considerable percentage of minute fragments of mussel shell, and of small fragments of bones, too much splintered to identify, but apparently the long bones of wading birds and of the larger fishes.

Of the stone implements, the most noticeable specimen, on account of size, was the large "corn-mill;" a heavy quartzite (?) stone, some fifteen inches in length by ten in width. It was lying in a shallow depression in the floor of the homestead, at the right hand side of the fire-place, and within a foot of the row of white stones that marked that feature of the "find." The mill had but a slight depression on its upper surface, not a quarter of an inch deep, yet clearly traceable on examination, and had evidently been but little used. Lying near it, were two crushing stones, one of which was undoubtedly used in connection with the "mill." It is a flat, nearly circular pebble, about four and one-half inches in diameter. One surface is merely levelled off, by constant rubbing, rather than pecked first and then ground. The opposite side has been pecked over the greater part of its surface, and the centre of the levelled surface has been somewhat hollowed

out, and is smoother than the surrounding merely hammered portion. Associated with the above was a globular quartz pebble, three inches in diameter, that may have been used in connection with the "mill," instead of the crusher we have described; or, in first breaking the hard grains of corn the pebble may have been used, and the flat stone then used to reduce the cracked corn to meal.

Mr. Evans figures (Anc. Stone Impl. G. B. p. 224, fig. 169) a "hammer stone," in size and shape identical with that we have described; and on pages 232–4 describes, under the name of "querns," grain mills, that are in every respect identical, except that as a class they may be larger and more elaborate in finish.

Near the mill and its accompanying stones, just described, we found four "net-weights" as they are usually called. One was a globular pebble, with a shallow depression about it, that was roughly and very irregularly pecked. Another was a flattened pebble, with a notch well defined at each side; being of the more abundant form of "sinkers," but much thicker than the other two specimens, and than the notched weights generally are. One of the two thin, flat specimens was of more interest than these specimens usually are, in that there were three well defined notches. It is not easy to determine the use of this third notch.

Near the sinkers were five rudely chipped implements (?) or more probably failures. While exhibiting abundant traces of having been worked by man, it is doubtful if they were ever put to any use. Their general appearance was not that of cores, either, from which flakes had been struck; nor was there any trace of chipping having been carried on within the limits of the homestead we are now describing. A very rude implement is frequently found in this neighborhood, but on it a cutting edge is always a noticeable feature; but in these there was nothing that could be called a cutting edge, except at one part of the larger of the five specimens.

On referring to illustrations of "drift" implements in Mr. Evans' work above quoted, and to "Reliquiæ Aquitanicæ," we find many so-called implements fully as rude as the least finished of the five above mentioned. What gives to these a peculiar interest, however, is not their similarity to the "drift implements" of Europe, but their association with some of the very finest wrought stone implements and arrowheads. It is a puzzle to know what the fash-

ioners of these latter could want, or do, with what, at best, are merely broken stones.

There were also three well marked hammer stones of the common pattern. Flat, oval pebbles, well battered at the ends, and side depressions for the thumb and second finger, the forefinger being curled over the hammering end *not in use;* as both extremities show that they have been each well used. These hammer stones are identical in form with those found in Great Britain, as will be seen on reference to Mr. Evans' work, pages 214–20.

There was also found with these hammers, half of a very pretty hone, which long usage has worn down to very smooth surfaces. The specimen, if broken in halves, has been about five inches long, and is one and one-quarter inches in length, by scant half an inch in thickness. The two sides are both perfectly level to within a short distance of the edge, when they slope off at a slight angle.

Hones of this character, and others with curved sharpening or polishing surfaces, are met with on the surface, where the commoner forms of relics are found, but they are not abundant.

There were also two cylindrical stones, of a pestle-like appearance, that were, of course, brought by the former occupants of this camp or homestead, to the enclosure we are describing, but whether used as pestles or selected for polishing stones, but never used, it is very hard to decide; and with these may be mentioned a curiously worn pebble that has much the appearance of having been commenced for a polished skinning knife, and never completed. As the superincumbent earth was purely a vegetable mould, and contained no pebbles, it is not likely that either this or the "pestles" got within the "find," and became associated with the unquestionable relics, by mere accident.

One naturally expects to find those chipped flints that are universally known as "scrapers," in every considerable "find" of stone implements; nor were they here wanting; two specimens of unquestionable scrapers being found, and an allied form of chipped jasper, that seems to be a connecting link, as it were, between scrapers and lance-heads; the specimen has the appearance of having been commenced for a spear and, injured for that purpose by an unlucky blow, subsequently chipped into its present shape and made to answer as a scraper.

The two genuine scrapers that were found, are of unusual interest, in being strictly of the European form, and not in any way

similar to the elaborately chipped jaspers, that are so abundant on the surface, and which are believed also to have been scrapers.

The two scrapers found measure about three inches in length, by one and three-quarters in breadth. They are irregularly oval, with the under surface, in each case, being nearly the plane of a single cleavage. They are both chipped from the same block or core of stone, a bluish grey jasper, of which many of the finest arrowheads were made.

The larger of the two scrapers bears a remarkable resemblance to a Bridlington scraper, figured in Mr. Evans' work, page 276, fig. 218; but is about double the size.

An implement was found near the scrapers, that we will next refer to, before noticing the weapons proper; the specimen being a finely polished skinning knife, of more than ordinary beauty of finish. This fine "celt," as it would be called in England, measures but three inches and one-quarter in length, and has a cutting edge a trace over an inch in extent. The surface generally is polished; but most care has been taken with the cutting qualities of the instrument, and the edge and sides adjoining it have received a polish that we have never seen excelled in any stone implement. The material looks like a conglomerate of quartz and agate.

The only other domestic implement was a rough gouge, made of serpentine and with the edge well preserved. The specimen measures seven inches in length; the edge and a distance therefrom of about one and one-half inches is entire and this portion is quite well polished, while the remainder apparently never has been. The edge, which is very slightly curved, measures one and one-half inches in width; the corners of the blade being protected by a narrow ridge, which gradually widens as it recedes from the cutting edge.

Nothing further of a domestic nature was found, or indeed, was present on the spot; for most thorough search was made, under very favorable circumstances; but opposite the fire-place, in what appeared to have been three separate heaps which were unfortunately mixed together in uncovering them, was a fine series of arrow and spear points, and one or two chipped jasper specimens, similar to, but not unquestionably lanceheads.

The arrowheads being the most prominent portion of this part of the "find," we will first give a hurried enumeration of their numbers and types. Mineralogically, this lot of arrowheads was

interesting, in showing a good deal more than usual variation in the materials used. The minerals being quartz, purple, yellow, and brown jasper, hornstone, slate, sandstone, and a peculiar conglomerate containing mica, not often met with in the shape of relics.

Considered in the matter of types, we found there were sixteen stemmed arrowpoints, of large size, excellent workmanship, and all of jasper, of the various colors in which this mineral occurs. Six of these specimens were barbed and stemmed, the others had simply a projecting tang. Four were flat, thin and sharply edged; the others mostly with a median ridge.

There was also a pretty, triangular arrowpoint, two and one-half inches long, and one and one-half inches wide at the base; and a quartz point that was pentagonal, approaching thus the leaf-shaped form, which was noticeably absent in this find.

The white quartz arrowpoints numbered forty-four specimens, and as a rule were small, and of less finish than specimens of this mineral are apt to be. Twenty-nine were stemmed; five were of the "lozenge" pattern, and ten were triangular specimens, these latter all having the concave base. Of the stemmed specimens only three had "notched bases."

Of what might be called common specimens, there were forty-eight that could be separated into six types, as follows: seven were lozenge-shaped points, and excellent examples of this form; ten were triangular points, four with concave bases, five with straight bases, and one with a convex base, being *almost* a leaf-shaped specimen; two were true leaf-shaped points; and one of this pattern, but stemmed also, being a form not often met with; ten were excellent *barbed* arrowpoints, that is, with the corners of the blade sharply pointed and making the base of the blade much wider than the stem; eleven specimens were of the "notched base" pattern, *i. e.* with a stem about as wide as the blade, and separated from it only by a semicircular notch or indentation; seven were plain stemmed points, a form that is not readily distinguished from the lozenge shape, as we recognize that pattern among the specimens gathered by us. Indeed, the plain stemmed arrowpoint graduates readily into the true leaf-shaped form.

Of spearheads there were but five specimens; two short stemmed examples, made of slate, and in no way noticeable. A third was of slate also, but much more carefully wrought, and a beautiful example of the "notched base" pattern. It measured four

inches, lacking an eighth, and was noticeable particularly for the median ridge running its whole length and from this ridge the specimen was very regularly bevelled to the sides. The notches at the base were large and deep, and the stem narrower than the base of the blade. The fourth example of the spearheads was like the preceding but about one third shorter. The remaining spearhead was more interesting, in that it nearly approached the true leaf-shaped pattern; a blunt barb-like widening at the base making it vary from that form a little, the stem or base itself being rounded.

Before noticing the collection of knives, as we propose calling a series of implements contained in this "find," we will briefly allude to three other specimens, that seem different in some respects from any of the above. One is a roughly chipped implement of agate, three inches in length, and a trace over two in greatest width. The base is blunt, being the natural surface of the pebble from which the specimen was chipped; the edges, although crooked, are sharp, and the point well defined and still acute. The specimen itself suggests a small lancehead, an unfinished knife, or a small hatchet, that might have been used to split long bones, that the marrow might be secured. It is much less finished and finely flaked than the jasper lanceheads we have so frequently met with on the surface and in graves. The second of these three specimens is a beautifully chipped jasper specimen, that appears to have been a long stemmed spear, which, being broken near the base, has had the fractured end carefully rechipped. As the specimen now is, it is a triangular "flint," two and five-eighths inches long, and one and one-half inches wide. It may be looked upon as a knife made from a spear, we suppose; inasmuch as so many, approaching it in character, were found at the same time. The third specimen is a rudely chipped oval knife (?) blade, noticeable as having been made of white quartz; a mineral not often used except for arrow-heads.

We have now to consider a remarkable series of hornstone implements, forty-two in number, which have much of interest connected with them. As a class, they may be said to approach the flint dagger blades figured by Mr. Evans, on page 315 of his work on the Stone Implements of Great Britain. They can be described as "chipped flints," with square bases, well defined points, and slightly convex sides, averaging three and one-half inches in length by one inch in breadth. Six of them have convex

bases, and consequently are leaf-shaped arrowpoints of a large size. In no one specimen is there any distinct notching of the sides, near the base, to facilitate the fastening of a handle; and for this reason we have thought that they may have been knives, rather than spearpoints or arrowpoints; but it is possible that they were intended as war arrowheads, and were to be only slightly inserted in the shaft; so that the person shot could not dislodge the stone point, by drawing the shaft from the wound. It seems almost useless to conjecture as to the particular use of these or indeed any specimens, which, from their shape and size, show that they may have been used for several different purposes.

A fact, fully as interesting as the presence of any or all of these relics, consists in the absence of two common forms of "Indian relics," namely: the ordinary grooved cobble-stone axe, and fragments of pottery; no specimen of the former or trace of the latter could be found anywhere about the limits of the beaten discolored ground that we have called a homestead.

Now arises the question, whence came the people who once occupied this spot, and left these abundant traces of their sojourn here? Marking the degree of civilization, or rather, of its absence, as estimated by these relics, does it, indeed, seem possible, as sketched by Haeckel,* that from hypothetical Lemuria, in the Indian ocean, a being worthy *then* to be called a man, could finally, after many ages, reach North-west America, and then cross our broad continent, to reach the Atlantic coast, in a state of advancement only equal to the production of such rude stone implements as we have described? We do not doubt the correctness of the theory of the evolution of man from creatures not men, but that the ancestors of the American red-skin lived nearer home than the Indian ocean, we cannot but think; and we fail, as yet to see, *how* "the dispute between the monogenists and the polygenists can die a silent and unobserved death;"† unless indeed it be by the final victory of the polygenetic school.

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* Reproduced by Chapman in "Evolution of Life," p. 177.
† Descent of Man, vol. 1, p. 235. English edition.

# THE GEYSERS OF MONTANA.

The first detailed account we have of these wonders of geology was published by Mr. N. P. Langford, who was one of an exploring party under General Washburn, sent out in the summer of 1870. His article was published in "Scribner's Monthly," while the official report to Congress was written by Lieutenant Doane, U. S. A. From Professor F. V. Hayden's interesting and valuable report for 1871 we take the following still more extended account of these geysers, and are indebted to him for the use of the accompanying illustrations.

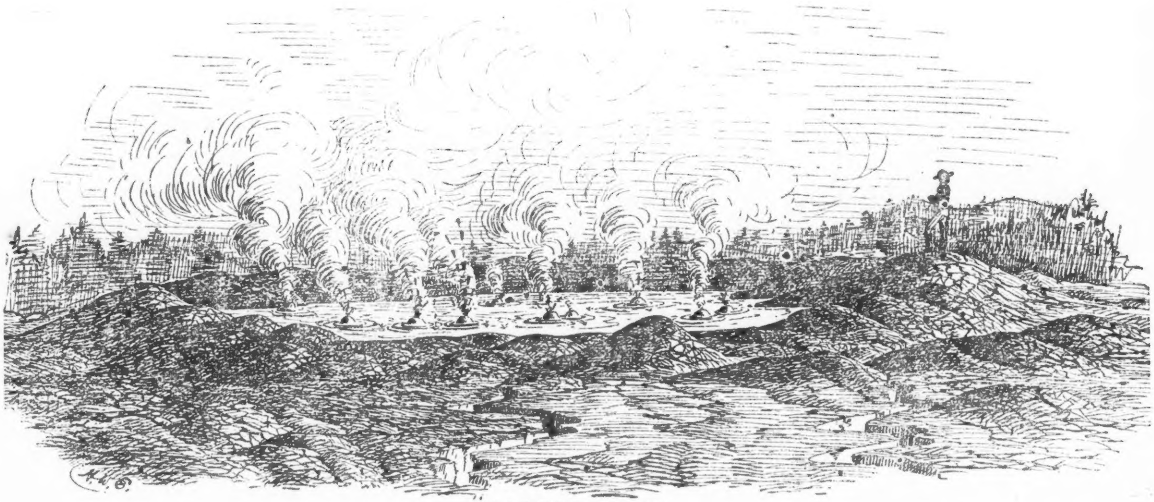
The geyser basin of Fire Hole river is near Yellowstone lake, the source of the Yellowstone river, of the wonders of which we give some account elsewhere in this number.

In the course of their wanderings in search of the Fire Hole basin the party under Prof. Hayden fortunately struck the sources of the East Fork of the Madison instead of those of the Fire Hole, and thus were enabled to see many fine springs which would otherwise have escaped attention, and there is no doubt, says Prof. Hayden, that subsequent explorations about the sources of the Yellowstone, Missouri and Snake rivers, will reveal many other groups of hot springs and geysers.

The entire valley of the East Fork, from its source to its junction with the Madison, extending over an area twenty-five miles long, and an average of half a mile in width, is covered with the silicious deposits of the hot springs, ancient and modern. The bed of the stream is lined with white silica, and the valley itself looks like an alkali flat. One group of thirty or forty springs is noticed, and the springs of the Lower Geyser basin are described and mapped. The main basin, the most beautiful of all in this last group, was ten by fifteen feet, the water 128°, marvellously transparent and of a most delicate blue; as the surface is stirred by the passing breeze, all the colors of the prism are shewn, literally a series of rainbows. He calls the most delicately colored springs Prismatic springs.

Entering the Fire Hole basin, the party visited one of the most remarkable mud-pots in the valley (Fig. 57). "The diameter

Fig. 57.



Mud Puff, Lower Fire-hole.

within the rim is forty by sixty feet, and forms a vast mortar bed of the finest material. The surface is covered with large puffs, and as each one bursts, the mud spurts upwards several feet with a suppressed thud. The mud is an impalpable, silicious clay, fine enough, it would seem, for the manufacture of the choicest ware. The colors are of every shade, from the purest white to a bright rich pink. The surface is covered with twenty or thirty of these puffs, which are bursting each second, tossing the mud in every direction on to the broad rounded rim. There are several other mud puffs in the vicinity, but they do not differ materially from the last, except in size."

We now come to the genuine geysers. Fig. 58 gives a view of one of the elevated craters called the Bee Hive; another much

Fig. 58.

The Bee-hive.

larger is styled the White Dome. "The broad mound is fifteen feet high, and upon this is a chimney about twenty feet in height. The steam issues steadily from the top like a high pressure engine."

We copy Prof. Hayden's description of this wonderful valley: —

"Early in the morning of August 30, the valley was literally filled with columns of steam, ascending from more than a thousand vents. I can compare the view to nothing but that of some manufacturing city like Pittsburgh, as seen from a high point, except that instead of the black coal smoke, there are here the white delicate clouds of steam. Small groups or solitary springs that are scattered everywhere in the woods, upon the mountain-sides, and which would otherwise have escaped observation, are detected by the columns of steam. It is evident that some of these groups of

springs have changed their base of operations within a comparatively recent period; for about midway on the east side of the lower basin there is a large area covered with a thick, apparently modern, deposit of the silica, as white as snow, while standing quite thickly all around are the dead pines, which appear to have been destroyed by the excessive overflow of the water and the increased deposition. These dry trees have a most desolate look; many of them have fallen down and are incrusted with the silica, while portions that have fallen into the boiling springs have been reduced to a pulp. This seems to be one of the conditions of silicification, for when these pulpy masses of wood are permitted to dry by the cessation of the springs, the most perfect specimens of petrified wood are the result. In one instance a green pine-tree had fallen so as to immerse its thick top in a large hot basin, and leaves, twigs and cones had become completely incrusted with the white silica, and a portion had entered into the cellular structure, so that when removed from the water, and dried in the sun, very fair specimens were obtained."

Fig. 59.

Grand Geyser.

The Upper Geyser basin contains the most remarkable geysers, of which the first one is the Grand Geyser (Fig. 59). Says Hayden:—

"Soon after reaching camp a tremendous rumbling was heard,

shaking the ground in every direction, and soon a column of steam burst forth from a crater near the edge of the east side of the river. Following the steam, arose by a succession of impulses, a column of water, apparently 6 feet in diameter, to the height of 200 feet, while the steam ascended a thousand feet or more. It would be difficult to describe the intense excitement which attended such a display. It is probable that if we could have remained in the

Fig. 60.

Grand Geyser, Upper Geyser Basin, Fire-hole River.

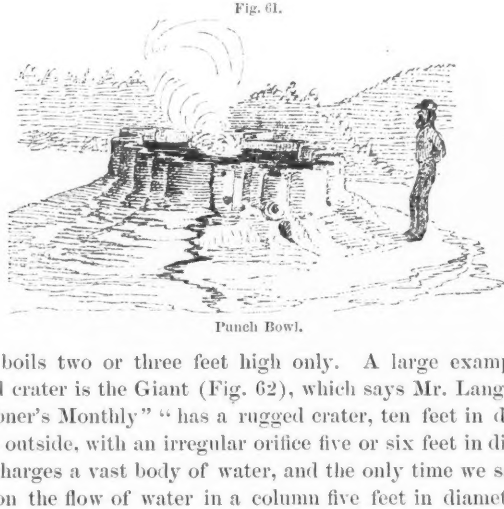
valley several days, and become accustomed to all the preliminary warnings, the excitement would have ceased, and we could have admired calmly the marvellous ease and beauty with which this column of hot water was held up to that great height for the space of twenty minutes. After the display is over the water settles down in the basin several inches, and the temperature slowly falls to 150°. We called this the Grand Geyser, for its power seemed

greater than any other of which we obtained any knowledge in the valley. (Fig. 59.) There are two orifices in one basin; one of them seems to have no raised rim, and is a very modest-looking spring in a state of quiescence, and no one would for a moment suspect the power that was temporarily slumbering below. The orifice is oblong, 2½ by 4 feet, while for the space of 10 feet in every direction around it are rounded masses of silica, from a few inches to 3 feet in diameter, looking like spongiform corals. Nothing could exceed the crystal clearness of the water."

Fig. 60 gives a view of another eruption of the same geyser.

As an example of exhausted geysers may be cited the Punch Bowl (Fig. 61), which is a low crater or chimney in which the

Fig. 61.



Punch Bowl.

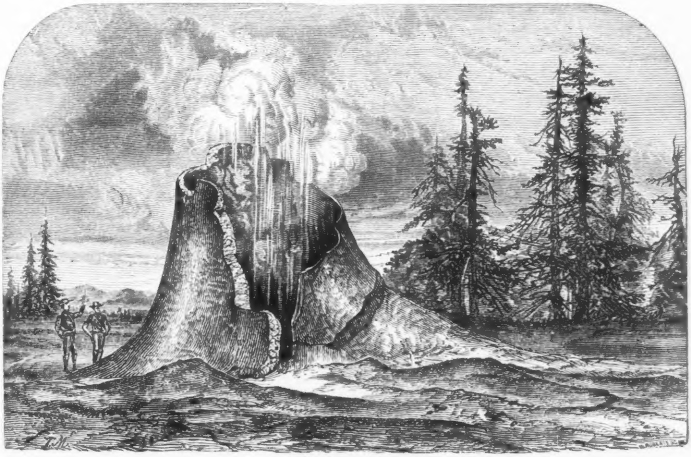
water boils two or three feet high only. A large example of a rugged crater is the Giant (Fig. 62), which says Mr. Langford, in "Scribner's Monthly" "has a rugged crater, ten feet in diameter on the outside, with an irregular orifice five or six feet in diameter. It discharges a vast body of water, and the only time we saw it in eruption the flow of water in a column five feet in diameter, and one hundred and forty feet in vertical height, continued uninterruptedly for nearly three hours. The crater resembles a miniature model of the Coliseum."

The "Giantess," however, honored the party with a grand eruption, an account of which we give in Prof. Hayden's own words: —

"Our search for new wonders leading us across the Fire-Hole river, we ascended a gentle incrusted slope, and came suddenly upon a large oval aperture with scalloped edges, the diameters of which were 18 and 25 feet, the sides corrugated and covered with

a grayish-white silicious deposit, which was distinctly visible at the depth of 100 feet below the surface. No water could be discovered, but we could distinctly hear it gurgling and boiling at a great distance below. Suddenly it began to rise, boiling and spluttering, and sending out huge masses of steam, causing a general stampede of our company, driving us some distance from our point of observation. When within about 40 feet of the surface, it became stationary, and we returned to look down upon it. It was foaming and surging at a terrible rate, occasionally emitting small jets of hot water nearly to the mouth of the orifice. All at once it seemed seized with a fearful spasm, and rose with incredible rapidity, hardly affording us time to flee to a safe distance, when it burst from the orifice with terrific momentum, rising in a column

Fig. 62.



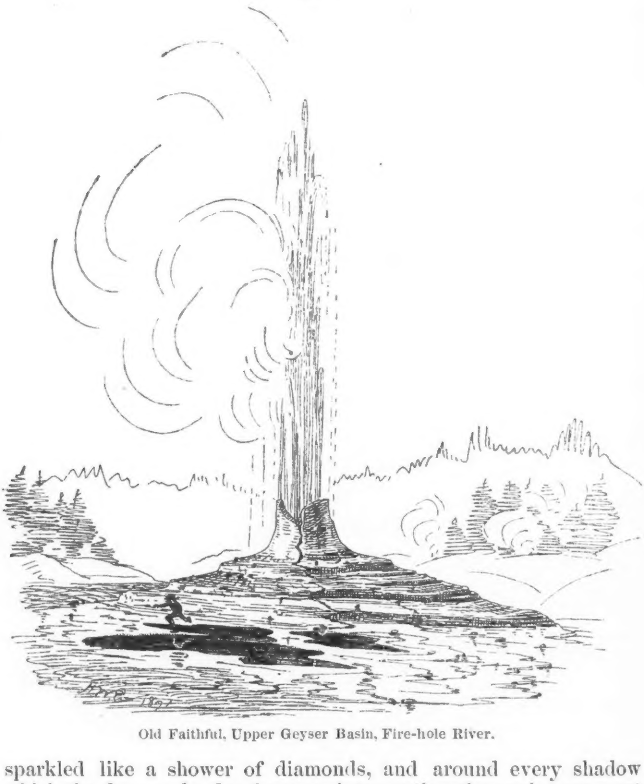
The Giant.

the full size of this immense aperture to the height of 60 feet; and through and out of the apex of this vast aqueous mass, five or six lesser jets or round columns of water, varying in size from 6 to 15 inches in diameter, were projected to the marvellous height of 250 feet. These lesser jets, so much higher than the main column, and shooting through it, doubtless proceed from auxiliary pipes leading into the principal orifice near the bottom, where the explosive force is greater. If the theory that water by constant boiling becomes explosive when freed from air be true, this theory rationally accounts for all irregularities in the eruptions of the geysers.

This grand eruption continued for twenty minutes, and was the most magnificent sight we ever witnessed. We were standing

on the side of the geysers nearest the sun, the gleams of which filled the sparkling column of water and spray with myriads of rainbows, whose arches were constantly changing — dipping and fluttering hither and thither, and disappearing only to be succeeded by others, again and again, amid the aqueous column, while the minute globules into which the spent jets were diffused when falling

Fig. 63.



Old Faithful, Upper Geyser Basin, Fire-hole River.

sparkled like a shower of diamonds, and around every shadow which the denser clouds of vapor, interrupting the sun's rays, cast upon the column, could be seen a luminous circle radiant with all the colors of the prism, and resembling the halo of glory represented in paintings as encircling the head of Divinity. All that we had previously witnessed seemed tame in comparison with the perfect grandeur and beauty of this display. Two of these wonder-

ful eruptions occurred during the twenty-two hours we remained in the valley. This geyser we named "The Giantess."

Another fine geyser is "Old Faithful" (Fig. 63), as it was christened by Messrs. Langford and Doane. It shoots up a column of water about six feet in diameter to the height of 100 to 150 feet, "and by a succession of impulses seemed to hold it up steadily for the space of fifteen minutes, the great mass of water falling directly back into the basin, and flowing over the edges and down the sides in large streams. When the action ceases, the water recedes beyond sight, and nothing is heard but the occasional escape of steam until another exhibition occurs."

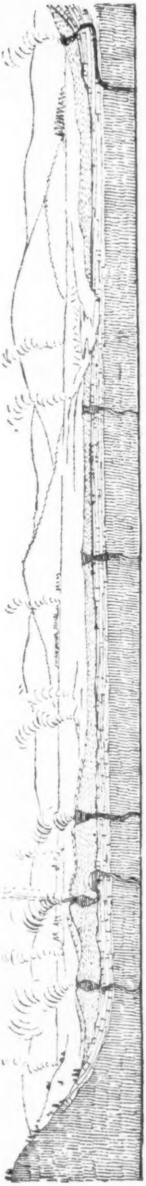


Fig. 64.

Ideal Section, Upper Geyser Basin, Fire-hole River.

Fig. 64 is an ideal section of a portion of the Upper Geyser Valley sketched by Mr. Elliott for the purpose of conveying a "clearer conception of the way in which we may suppose the waters of many of the springs reach the surface. The lower portion of the section is basalt, then lake or local drift deposits, and thirdly the crust of silica, which forms a floor of greater or less thickness for the entire valley."

It is evident that the geysers of Iceland are tame in comparison with those of Montana, while the latter are similar to those of New Zealand. Concerning the origin of geysers, Hayden quotes as follows from Hochstetter's "New Zealand:"

"Both kinds of springs owe their origin to the water permeating the surface and sinking through fissures into the bowels of the earth, where it becomes heated by the still existing volcanic fires. High-pressure steam is thus generated, which, accompanied by volcanic gases, such as muriatic acid, sulphurous acid, sulphuretted hydrogen, and carbonic acid, rises

again toward the colder surface, and is there condensed into hot water. The over-heated steam, however, and the gases decompose the rock beneath, dissolve certain ingredients, and deposit them on the surface. According to Bunsen's ingenious observations, a chronological succession takes place in the coöperation of the gases. The sulphurous acid acts first. It must be generated there where rising sulphur vapor comes into contact with glowing masses of rock. Wherever vapors of sulphurous acid are constantly formed, there acid springs, or solfataras, arise. Incrustations of alum are very common in such places, arising from the action of sulphuric acid on the alumina and alkali of the lavas; another product of the decomposition of the lavas is gypsum, or sulphate of lime, the residuum being a more or less ferruginous fumarole clay, the material of the mudpools. To the sulphurous acid comes sulphuretted hydrogen, produced by the action of steam upon sulphides, and by the mutual decomposition of the sulphuretted hydrogen and sulphurous acid, sulphur is formed, which in all solfataras forms the characteristic precipitate, while the decomposition of silicious incrustations is either entirely wanting or quite inconsiderable, and a smell of sulphuretted hydrogen is but rarely noticed. These acid springs have no periodical outbursts of water.

In course of time, however, the source of sulphurous acid becomes exhausted, and sulphuretted hydrogen alone remains active. The acid reaction of the soil disappears, yielding to an alkaline reaction by the formation of sulphides. At the same time the action of carbonic acid begins upon the rocks, and the alkaline bicarbonates thus produced dissolve the silica, which, on the evaporation of the water, deposits in the form of opal, or quartz, or silicious earth, and thus the shell of the springs is formed, upon the structure of which the periodicity of the outbursts depends. Professor Bunsen, rejecting the antiquated theory of Makenzie, based upon the existence of subterraneous chambers, from which the water, from time to time, is pressed up through the vapors accumulating on its surface, according to the principle of the Hern fountain, has proved in the case of the great geyser that the periodical eruptions or explosions essentially depend upon the existence of a frame of silicious deposits, with a deep, flue-shaped tube, and upon the sudden development of larger masses of steam from the overheated water in the lower portions of the tube. The deposition of silica in quantities sufficient for the formation of this spring apparatus in the course of years takes place only in the alkaline springs. Their water is either entirely neutral or has a slightly alkaline reaction. Silica, chloride of sodium, carbonates, and sulphates are the chief ingredients dissolved in it. In the place of sulphurous acid the odor of sulphuretted hydrogen is sometimes observed in these springs.

The rocks, from which the silicious hot-springs of New Zealand derive their silica, are rhyolites, and rhyolithic tufas, containing seventy and more per cent. of silica; while we know that in

Iceland palagonite, and palagonitic tufas, with fifty per cent. of silica, are considered as the material acted upon and lixiviated by the hot water. By the gradual cooling of the volcanic rocks under the surface of the earth in the course of centuries the hot springs also will gradually disappear; for they too are but a transient phenomenon in the eternal change of everything created." — (Hochstetter's "New Zealand," English translation, p. 432.)

Bischof in his "Researches into the internal heat of the globe," thus discourses on the origin of the Geysers of Iceland: —

"No doubt can be entertained respecting the nature of the agent by which the waters of the geyser, the Strokr, and other less considerable springs, are thrown to such an immense height. It is, as in volcanoes, a gaseous body, principally aqueous vapor. We may, therefore, very fairly agree with Krug Von Nidda, and consider volcanoes in the same light as intermittent springs, with this difference only, that instead of water, they throw out melted matters.

"He takes it for granted that these hot springs derive their temperature from aqueous vapors rising from below. When these vapors are able to rise freely in a continual column, the water at the different depths must have a constant temperature, equal to that at which water would boil under the pressure existing at the respective depths; hence the constant ebullition of the permanent springs and their boiling heat. If, on the other hand, the vapors be prevented by the complicated windings of its channels from rising to the surface; if, for example, they be arrested in caverns, the temperature in the upper layers of water must necessarily become reduced, because a large quantity of it is lost by evaporation at the surface, which cannot be replaced from below. And any circulation of the layers of water at different temperatures, by reason of their unequal specific gravities, seems to be very much interrupted by the narrowness and sinuosity of the passage. The intermitting springs of Iceland are probably caused by the existence of caverns, in which the vapor is retained by the pressure of the column of water in the channel which leads to the surface. Here this vapor collects, and presses the water in the cavern downward until its elastic force becomes sufficiently great to effect a passage through the column of water which confines it. The violent escape of the vapor causes the thunder-like subterranean sound and the trembling of the earth which precedes each eruption. The vapors do not appear at the surface till they have heated the water to their own temperature. When so much vapor has escaped that the expansive force of that which remains has become less than the pressure of the confining column of water, tranquillity is restored, and this lasts until such a quantity of vapor is again collected as to produce a fresh eruption. The spouting of the spring is therefore repeated at intervals, depending upon the capacity of

the cavern, the height of the column of water, and the heat generated below."

With this work and the admirable series of photographs by Mr. Jackson (both in sheets * and stereoscopic form, published by Prof. Hayden) of some of the finest views in the National Yellowstone Park and Colorado Territory, the reader can obtain a very clear idea of the Geyser region, of the springs in course of eruption, and of the falls and basin of the Yellowstone. We see by the papers that it is proposed to open roads into the National Park, and erect hotels at the Geysers for the convenience of the public.

## ON SOME OF PROF. MARSH'S CRITICISMS.

BY E. D. COPE.

### I.

I have already (in "The short-footed Ungulata of the Eocene of Wyoming;" Naturalists' Agency, Salem, Mass.) shown, by figures and descriptions, the absence of foundation for Professor Marsh's recent animadversions, and though these latter present internal evidence of idiosyncracy which almost disarms reply, yet as some of the readers of this journal may not see the above essay, I make a few specific contradictions of some of his statements which may be regarded as serious.

In an article "On the Gigantic Fossil Mammals of the Order Dinocerata," he writes as follows:

"(1) What Prof. Cope has called incisors are canines, etc." I had determined and stated them to be canines, in the American Naturalist, previous to the appearance of this criticism.

"(2) The stout horns he described are not on the frontals but on the maxillaries." I was the first to determine these bones to be nasals, and find that in *Eobasileus* they compose the inner face of the horns to the apex, while the maxillaries form the outer face. †

* Sun Pictures of Rocky Mountain Scenery. By F. V. Hayden. The Rocky Mountain Album. By F. V. Hayden and A. H. Jackson, Photographer.

† (See my paper, p. 18). Professor Marsh has since contradicted the former statement flatly.

"(3) The orbit is not below these horns but quite behind them, and has over it a prominent ridge on the frontal." In *Loxolophodon cornutus* the naso-maxillary horn is largely above the orbit, and there is no superciliary ridge of the frontal.

"(4) The occiput is not vertical, but extends obliquely backward, the occipital crest projecting behind the condyles." Prof. Marsh has been perhaps led into this error by the imperfection of the occipital condyles in his specimen. He does not appear to know that in life the head was directed obliquely downwards, so that the occipital crest was vertical as I described it in *Loxolophodon* and in *Uintatherium robustum*.

"(5) The temporal fossa is not small posteriorly but unusually large;" and "(7) the spine of the tibia is not obtuse but wanting," are frivolous; *vide* my descriptions, *l. c.*

"(6) The great trochanter of the femur is recurved, though Prof. Cope says not." It is flat, as in the elephants.

"(8) One of the species named by Prof. Cope, *Eobasileus furcatus*, is based on what he regards as portions of the nasal bones. The description, however, indicates that these specimens are merely the posterior horn-cores of well-known species." In the location of these cores Prof. Marsh may be correct, but demonstration is yet wanting. How "well-known" these species are to Prof. Marsh, will be evident shortly; and how they could be well-known to anybody else, may be determined by reference to his brief notices of a few of them published to the date of his writing.

Omitting notice of sundry insignificant questions raised in a postscript to the paper, as well as those which are more or less repetitions of criticisms already made, I pass to his denial of the possession of a proboscis to these animals. I retain my belief that they had such an organ, and refer to my essay above cited for the proofs. Leidy has suspected its presence in *Megaceratops*. He then says "(7th) the malar bone does not form the middle element of the zygomatic arch, but the anterior as in the tapir." It forms the middle element in *Loxolophodon*, as may be seen from my figures. Below, its maxillary support forms one-third of the zygoma, at the side a little less, and above, a narrow lamina of the malar extends nearly to the lachrymal.

"(9) The nasal bones are not deeply excavated at their extremities." They are excavated, etc., as I have described.

Now it is easy to see by an examination of Professor Marsh's figures of *Uintatherium mirabile* where all this blundering criticism comes from, and I have pointed out to him that this is the source of error. But Professor Marsh evidently desires no such consideration from my hands, but repeats his statements, as though *Uintatherium* were a Rosinante, and the ninth commandment a wind-mill.

There is no inaccuracy in my statement of dates of publication of Professor Marsh's genera. I have never stated that the name *Tinoceras* was proposed August 24th, but that it was referred to the *Proboscidia* at that date. This name was published in an erratum on August 19th, but was never described until September 21st and then only by implication in the description of a species. *Loxolophodon* and *Eobasileus* were described August 19th and 20th, with separate diagnoses.

I am charged with giving an erroneous date to his communication of December 20th before the American Philosophical Society. This will also be found to be correct by reference to the report of my communication (Proceedings Academy Natural Sciences, January 14th, 1873).

Having already gone into the discussion of the affinities of these animals, I run rapidly over the characters assigned by Prof. Marsh to a supposed new order *Dinocerea* (which he now spells as corrected, *Dinocerata*). Those from the first to and including the fourth are entirely trivial; the last, which denies air cavities to the cranium is moreover untrue, as they exist in the squamosal region as I have stated. The fifth is not true of all the genera. The definitions from the seventh to the eleventh are of no weight whatever. As the twelfth, he gives "the very small molar teeth and their vertical replacement." This is precisely the state of things in the proboscidian *Dinotherium*, a form which Prof. Marsh has overlooked. The 13th and 15th, "the small lower jaw," and "absence of hallux" are of no weight if true; but the lower jaw has marked proboscidian features in the symphysis and teeth, and it is probable that some of the species had a hallux. The 16th, "absence of proboscis" is probably an error, certainly so for two of the genera. I have passed over the (6th) "the presence of large postglenoid processes," and (14th) "the articulation of the astragalus with both navicular and cuboid bones," as of some value. They are, indeed, the only characters of any wide systematic sig-

nificance adduced by Prof. Marsh, since they point indubitably to the *Perissodactyla* and are common to all of the *Eobasileidæ*. Nevertheless they form but a slim basis of support for an order of mammals, especially when compared with the uniform testimony of proboscidian affinity derived from the cranial expansions, cervical vertebræ, sacrum, pelvis, hind leg, hind foot, scapula, fore leg, fore foot, and the concurrent evidence derived from dorsal and lumbar vertebræ, dentition and proboscis.

If Professor Marsh wishes to see an equal or greater degree of variation in dentition in an order of mammals, let him compare *Equus* and *Rhinocerus* among *Perissodactyla*, or *Bos*, *Moschus*, *Hippopotamus* and *Phacochœrus* in the *Artiodactyla;* in the length of the nasal bones, *Delphinus* and *Squalodon* among *Cetacea*, or *Homo* and some of the lemurs; in the number of toes, *Felis* and *Mustela*, *Ursus*, etc., all members of the same orders.

I should be glad, on the principle of *De mortuis nil nisi bonum*, to commend our critic's remarks on the relations of this supposed order. But Professor Marsh's ideas on classification are derived from unusual sources. The absence of incisor teeth no more relates these animals to the *Artiodactyla* than it relates the sloth to the same order. The presence of paired horns no more constitutes affinity to the ruminants than it does in the case of the "horned-toad."

They are simply an analogous development on a proboscidian basis. The few affinities which this group exhibits outside the *Proboscidia*, are to the *Perissodactyla*, as I was the first to show, and among these, to *Palæotherium* and *Rhinocerus*. As to the name "*Dinocerata*," I have been induced to use it in the sense of a suborder, but am now satisfied that even this use is uncalled for, and shall employ the family name *Eobasileidæ* instead. On equally good bases the camel and *Tragulus* should be erected into new orders.

An explanation of the origin of this new order is probably to be found in the system of Mammalia proposed by Prof. Dana, some years since in accordance with his theory of "Cephalization." While I have been able to see beauty in Professor Dana's conception, the least that can be said is that the application to the Ungulata has not been the correct one. The system has not been adopted, and is in the opinion of the best mammalogists, entirely untenable.

Another critic not so courageous as Prof. Marsh, since he is anonymous, has attacked (Am. Jour. Sci. Arts, 1872, 489) my statement of determination of the Cretaceous age of the Bitter Creek coal, citing five authorities as having previously made the same determination. I have shown (Proc. Acad. Nat. Sci. Phila., Jan. 14, 1873) that but one of these references relates to the region in question, and that the critic was ignorant of the geography or literature of the subject, or both. He, however, repeats (loc. cit., 1873, 231) that Mr. Meek "referred Dr. Hayden's collection from Bitter Creek at Point of Rocks to the Cretaceous," a fact I had previously pointed out, and adds that I am in error in asserting that Mr. Meek attached interrogation marks to all his Coalville determinations (200 miles west), as he cites two *Cardia* and two *Inocerami* as from Coalville and without the question. More careful examination would have shown my critic that the two *Cardia* and one *Inoceramus* are stated to be from localities remote from both Coalville and Bitter Creek.

But there is no indication in my original note of a design to ignore the useful labors of the gentlemen who have written on this subject; nothing was farther from my intentions, in so issuing an early notice of my own observations, than to ignore the opinions of Mr. Meek, with which I have become pretty well acquainted through pleasant association on the same geological survey. Had they been coincident with my own, I should have mentioned them, although unpublished. Mr. Meek will, however, soon speak for himself. It requires but a casual examination to show that the criticism is captious and uncalled for, and that its author is only playing aid to the champion above considered.

## II.

I now turn to another subject, the raising of which is due also to Prof. Marsh. He has very commendably made himself acquainted with the literature of the authors who had previously written on these extinct *Proboscidia*, though not in time to prevent his redescribing some of the genera and species. But unfortunately he does not tell us all that he knows. He knows perfectly well that my descriptions antedate his by a month and more, and that he is posterior to Dr. Leidy, by two months at least. He is however not strong enough to state the nomenclature accordingly, but endeavors to prove something else. In order to do

this, he is willing to write (Amer. Journ. Sci. Arts, 1873, p. 118), "the dates on the papers (Aug. 20th and 22d) certainly do not represent those of actual publication;" and again (American Naturalist, 1873, p. 151) "no less than seven of Prof. Cope's papers are antedated, as the records of the society will show." Prof. Marsh is not careful to prevent the natural deduction from these statements, that the dates are fraudulent; though he well knows to the contrary, and disagreeable though it may be to the *mens conscia recti*, I am compelled to prove that such is not the case!

I therefore append testimonials from the proprietors and foremen of the printing establishment from which the essays in question were issued, and from my assistant who received and distributed them: —

PHILADELPHIA, March 24th, 1873.

Professor O. C. Marsh having stated in the "American Naturalist" (1873, p. 151) that some of the papers published by Professor Cope during the summer of 1872, and printed by us, bear dates "which do not represent those of publication" and that "at least seven of them are antedated," we hereby state that these dates are true, and that on the days stated from fifty to one hundred copies of these papers were delivered by us into the hands of Pendleton King and Stephen G. Worth, assistants of Professor Cope, except that on *Metalophodon*, which was issued to Professor Lesley.

McCALLA & STAVELY.

JNO. S. SCHEIDELL, *Foreman of Composing Room.*
JOHN DARDES, *Foreman of Press Room.*

LOUISIANA STATE UNIVERSITY,
*Baton Rouge*, March 24, 1873.

PROFESSOR E. D. COPE, *Academy Natural Sciences, Philadelphia.*

DEAR FRIEND: — On looking over my papers, I find that I have, among papers written by you, the following: —

On a new genus of *Pleurodira* from the Eocene of Wyoming, July 11, 1872.
On the Tertiary Coals and Fossils of Osino, Nevada, July 29th.
Descriptions of Some New Vertebrata from the Bridger Group of the Eocene, July 29th.
Second Account of Same, August 3d.
Third " " " " 7th.
On the Existence of Dinosauria in the Transition Beds of Wyoming.
Short Notice of Species of Loxolophodon (misprinted Lefalophodon) Cope, near August 17th
Notices of New Vertebrata from the Upper Waters of Bitter Creek, Wyoming Territory August 20th.
Second Notice of Extinct Vertebrates from Bitter Creek, Wyoming, August 22, 1872.

These I brought with me from Philadelphia, leaving early in September, 1872.

I laid them aside during July and August, and am confident that the dates which I find on them, as above, correspond with the times I received them from the printer.

Your instructions were for immediate distribution, which I followed, using the list of names of persons to whom they were to be sent. Some received them very soon, others after a short delay, as suited convenience in mailing; and I think all were mailed by the 1st of September.

You are at liberty to use this letter if desirable. Very truly,

PENDLETON KING,
*Professor of Natural History in the University of Louisiana.*

I now add testimonials from some of the persons to whom the papers in question were sent, although I consider this part of the evidence as quite immaterial, that which has gone before being

sufficient as to the date of publication. It is indeed not to be expected that persons will generally remember the exact dates at which printed matter has been received. Nevertheless in a few days after making inquiry I received the following: —

"Professor O. C. Marsh having stated in the "American Naturalist" (1873, p. 151), that some of the above papers were not published at the dates which they bear, and that "at least seven of them are antedated," I hereby state that most or all the above were received at my address or by me, at or near the dates printed on them, especially those of the summer months."

JAMES ORTON, *Professor of Natural History in Vassar College*, POUGHKEEPSIE, N. Y.
JAMES S. LIPPINCOTT, CORNING, New York.
E. T. COX, *State Geologist*, INDIANAPOLIS, Indiana.
CHAS. M. WHEATLEY, PHŒNIXVILLE, Pennsylvania.
WM. C. KERR, *State Geologist*, RALEIGH, North Carolina.
JOSEPH SAVAGE, LEAVENWORTH, Kansas.

I have also received letters from Principal Dawson of Montreal and Professor Mudge of the State Agricultural College, Kansas, stating that they received the papers, but did not keep exact account of the date of reception. Among many others in the United States to whom they were sent, I may mention Prof. Davidson, President of the San Francisco Academy Natural Sciences. They were also sent to Professors Seeley, Huxley, Gegenbauer, Peters, Hyrtl, Du Bocage and others in Europe, and Messrs. Gotch and Rijgersma in Australia and the West Indies respectively.

I also add that they were received at my address at Fort Bridger, and mostly forwarded to me promptly after the dates of distribution.

The little that interests students in this matter is the dates of publication of the essays in question. The dates of reading are of secondary importance and have been abandoned by naturalists generally as furnishing basis for nomenclature, so that Prof. Marsh's able criticism of the dates on the cover of the American Philosophical Society's proceedings for 1872 may be regarded as purely antiquarian. The papers in question were, in fact, issued independently of the society, and almost always in advance of the time at which they were read before it. But lest our bibliophile again charge me with fraud, let me here correct an error in the report of the proceedings of that society for August, 1872, in "Nature" for 1873, p. 335. Here it is stated that my first note on the Proboscidians was read on August 16th; I hasten to say that this is an error probably derived from the wording of the note as published on August 19th, in which it was stated (without my knowledge) that "The Secretary announced that he had re-

ceived from Prof. Cope," etc. This could only have referred to the last meeting preceding (on the 16th); but, in fact, it was not read until the meeting following (September 20th). In the mean time it had been published (on the 19th), and two other papers describing the species and genera in more detail were published on the 20th and 22nd respectively. An account embracing the same facts was also read by Prof. Winchell before the American Association for the Advancement of Science, which opened its sessions at Dubuque on August the 21st (or 23d), of which an abstract has, after great delay, appeared in the American Naturalist for March, 1873. Finally a description of *Eobasileus* appeared in the scientific column of the "New York Independent" for August 22nd, 1871. The papers published in Philadelphia were issued without my revision, and hence contain a few typographical errors which Prof. Marsh finds of great use to himself. But under the circumstances the number is surprisingly few.

I now present a table of the nomenclature of the three genera of *Proboscidia*, synonymy being in italics:—

| MONTH. | AUTHOR. | | |
|---|---|---|---|
| | Leidy. | Cope. | Marsh. |
| August, 1872. | | | |
| 1st. | Uintatherium described with one species. *Uintamastix* do. | | |
| 19th. | | Loxolophodon described with three species.* | *Tinoceras* used in erratum, not described; no species described. |
| 20th. | | Eobasileus described and one species. | |
| 22d. | | Loxolophodon again described with three species. | |
| 24th. | | | *Tinoceras* named; no description. |
| September. | | | |
| 21st. | | | *Tinoceras* described with one species described. |
| 27th. | | | *Dinoceras* described with two species. |

* In this communication the name *Loxolophodon* was misspelled Lefalophodon. As Prof. Marsh finds some difficulty in adopting the former name, I can accept the latter, should he insist on it.

Though Prof. Marsh has published five papers and six notes on these animals, but one of his species has been so far partially described as to be of any use to science. Publishing of bare names * may constitute a caveat, but not an injunction, but in the present case the dates are too late. Hence the trouble. "*Heu quantus erat sudor*," etc.

In one of Prof. Marsh's late catalogues, he asserts that *Loxolophodon cornutus* and *Tinoceras grandis* are identical. If this be true, the latter name must stand as a synonyme of the former, and *Tinoceras* be withdrawn from the synonymy of *Uintatherium*, where it might well remain so far as his description characterizes it. But if so, his statement that there are five superior molars must be altered, as the genus *Loxolophodon* possesses six. He has also stated that *Uintatherium robustum* possesses a small tubercle on one of the molars not found in *U. mirabile*, and bases a generic distinction between the species thereon; for use he at last succeeds in defining the latter as a species only.

Perhaps, however, Prof. Marsh desires to impose upon scientific literature the numerous names he has proposed for species he has never described.† This he has attempted in the case of the fossil American Turkey, *Meleagris superbus* Cope, which was described by the writer over a year sooner than by him. At the latter date this species was discovered to have been called *M. altus* Marsh, some months prior to my description, but without any allusion to its characters or other means by which it could be identified. If Prof. Marsh desires students to use his museum labels, without descriptions, he might refer to Bronn's "Lethæa Geognostica," and other works, where he will find all such names consigned to the rubbish of synonymy so soon as it can be ascertained to what they refer.

To sum up the matter, it is plain that most of Prof. Marsh's criticisms are misrepresentations, his systematic innovations are untenable, and his statements as to the dates of my papers are either criminally ambiguous or untrue. I might now proceed to

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* See the rule "adopted and practiced by most students. In case of a genus there must be a definition giving the essential characters." From "Thorell's European Spiders," quoted in Wallace's Address before the Entomological Society, London, and by W. H. Edwards in "Entomological Nomenclature" in "Canadian Entomologist," 1873, p. 32.

† Several of which owe their existence in literature to the descriptions which I have given, *e.g.*, *Thecachampsa squankensis* "Marsh," *Hadrosaurus minor* "Marsh."

characterize the effrontery of such proceedings in fitting terms, but forbear, believing that with a little change of scene the author of them will be as glad to bury them in oblivion as is the writer of this notice.

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## EXPLANATION OF PLATES.

PLATE 4. Front view of cranium of *Loxolophodon cornutus*, one-sixth natural size.
PLATE 5. Profile of the same (not in natural position) same proportion; compare with description.

# NEW PLANTS OF NORTHERN ARIZONA AND THE REGION ADJACENT.

BY SERENO WATSON.

In the botanical collections made in 1871-'72, mainly in the southern portion of the Great Basin, in northwestern Arizona and the adjacent desert section of California, by Mr. Ferd. Bischoff and others, under the direction of Lieut. G. M. Wheeler, Corps of Engineers, in the course of his exploration of that region, several new species have been found which are here described, by consent, in anticipation of the fuller report now in preparation. With these are given some others occurring in a small collection made by Mrs. Ellen P. Thompson near Kanab, Southern Utah, during the last summer while accompanying her brother, Maj. Powell, in his survey of the Colorado. Several of these species are of interest as confirming genera hitherto monotypical. Notes upon a few other species are added.

POLYGALA SUBSPINOSA.—Perennial, herbaceous, glabrous or more or less pubescent; stems 2-8' high, branched above, the branches often spinose; leaves scattered, ½ to 1' long, oblong or oblanceolate, acute or obtuse, attenuate to the base; raceme loose, few-flowered; bracts small and scarious; pedicels becoming reflexed, shorter than the flowers; sepals naked or ciliate, the wings oblong, 4-5'' long and equaling the petals; keel hooded, crested with a broad saccate process; style linear; capsule orbicular, emarginate, short-stipitate.—Near *P. Nutkana*, which has a linear or horn-shaped crest and is always nearly or quite glabrous and without spines. Silver City, Nevada (Kellogg, 1862), pubescent and very spiny; Arizona (Palmer), densely pubescent but without spines; Kanab (Mrs. E. P. Thompson), glabrous and spiny. Flowers "maroon and yellow;" on mountain summit; June.

PETALOSTEMON FLAVESCENS.—Stem simple, glabrous; stipules and leaves sparingly silky; leaflets 3-5, narrowly oblong, obtuse, 3-6'' long; spike dense, long-peduncled, the rachis subpubescent; bracts (and calyx) very silky-villous, subulate, 2'' long; upper tooth of the calyx subulate, narrowest and longest, equaling the tube; petals yellow, the limb of the banner quadrilateral, emarginate, equaling the claw, the

other petals narrowly oblong.—Kanab, Southern Utah (Mrs. E. P. Thompson), on dry rocky hills; June. *P. macrostachyus*, Torr., a somewhat similar, more northern species, with elongated spikes of white flowers, has 5 - 9 acute glabrous leaflets, the rachis, bracts and calyx very villous, the subulate bract long-acuminate, calyx-teeth equaling the tube, and the claw of the banner much exceeding the small deltoid-subcordate irregularly crenate limb.

In the collection from Kanab is another well-marked form, but probably referable to *P. Searlsiæ*, Gray—differing in the broad naked bract, rhomboidal above with a short filiform apex, attenuate to the base; calyx equally villous throughout; petals larger and broader, the banner entire or emarginate instead of crosely crenate. *P. ovatus*, Dougl., from Oregon, with violet flowers, is distinct from *P. macrostachyus*, to which it has been referred. There are other western species as yet undescribed.

DALEA AMŒNA.—Shrubby, much branched; pubescence short, silky, dense only in the upper axils; leaflets 7 - 11, narrowly linear, 3 - 4'' long, obtusish; flowers loosely racemed, few, large, deep-purple; pedicels 1'' long; calyx pubescent, 3 - 5'' long, the lanceolate acuminate teeth equaling the tube; petals 6'' long; ovary densely pubescent.—Allied to *D. Fremontii*, *Johnsoni* and *Schottii*. Northern Arizona (Mrs. E. P. Thompson). In damp places; April.

ASTRAGALUS AMPULLARIUS. (§ *Inflati*.)—Stems short, ascending; pubescence short, strigose, appressed; leaflets 7 - 11, obovate, 4 - 6'' long, emarginate, glabrous above; raceme short, ½ - 1' long, rather dense; calyx cylindrical-campanulate, 2 - 3'' long, the teeth very short or nearly obsolete; petals purple, the banner narrow, 7 - 9'' long, much exceeding the very obtuse keel; legume ascending, upon a long-exserted stipe, oblong, 9'' long, glabrous.—Kanab, Southern Utah (Mrs. E. P. Thompson). In damp places; April, May.

PETERIA THOMPSONÆ.—More or less hoary with short appressed hairs; stems herbaceous, 1° high or more; leaflets 6 - 10 pairs, obovate, 4 - 6'' long, obtuse, mucronulate; raceme dense; bracts linear-setaceous; calyx densely glandular-pubescent, the subulate teeth about equaling the tube and slightly shorter than the light-yellow corolla; banner orbicular, 6'' long; ovary sessile; pod 2' long, 2'' wide, glabrous, about 6-seeded. — Stipules spinose as in the original species, not subulate as described by Bentham and Hooker. The base of the style in both species is thickened and somewhat horny. Kanab (Mrs. E. P. Thompson). On dry rocky cliffs; July, August.

WHIPPLEA UTAHENSIS.—Shrubby, low (6' high), much branched; pubescence strigose, mostly appressed; leaves oblong, attenuate to a very short petiole, 3 - 5'' long, acutish, entire, sparingly hairy, 3-nerved; flowers small, few, on very short pedicels, in a dense compound cyme; calyx cylindrical-turbinate, the subulate lobes shorter than the white oblong clawed petals; stamens 10; styles 3 and ovary 3-celled; capsule oblong, terete, 1½'' long, adherent for half its length to the calyx-tube.—Especially distinguished from *W. modesta* by its elongated capsule. Bud-scales very silky. Kanab (Mrs. E. P. Thompson). On dry sandy cliffs; August.

ŒNOTHERA (CHYLISMA) MULTIJUGA.—Annual, glabrous, branched; radical leaves 6' long, narrow, pinnate with 12 or more pairs of leaflets, which are 9'' long, the alternate ones smaller, oblong, acute, irregularly and doubly toothed, strongly veined, the terminal leaflet not larger; raceme loose; pedicels slender, 1½' long, equaling the filiform angular ovary; calyx-tube 1 - 1½'' long, much shorter than the segments; petals yellow, 4'' long.—Near *Œ. scirpoides*, Nutt., but none of the forms of that variable species shew any approach to this in the regular pinnation and peculiar serration of the leaves. Northern Arizona (Mrs. E. P. Thompson). In dry places; March.

PETALONYX NITIDUS. Leaves ovate, ½ - 1' long, acute, coarsely toothed, shortly petioled, vitreous and shining, not greatly reduced on the branches; flowers in contracted cymose panicles; otherwise like *P. Thurberi*.—Southern Nevada (Wheeler).

CYMOPTERUS PURPUREUS.—Subacaulescent, glabrous; leaves 2 - 3-pinnate, broadly triangular in outline, 2 - 4' long including the petiole, the broad segments coarsely mucronate-dentate; peduncle stout, exceeding the leaves; umbel unequally 8 - 12-rayed, naked or with a single involucral bract; involucels unilateral, of several lanceolate segments united near the base, nearly equaling the flowers; sepals ovate, acute; petals yellowish-purple; fruit 4'' long, nearly as broad, with wide membranous wings, the pedicels as long or longer; seed concave, 3 costate, one or all of the corresponding

wings developing; vittæ 4–5 in the intervals, 8 upon the commissure.—Whole plant purplish; near *C. terebinthinus*, Nutt. New Mexico (Palmer, 1869). Northern Arizona (Mrs. E. P. Thompson). In damp, shaded soil; March.

PEUCEDANUM NEWBERRYI.—Acaulescent or nearly so, glabrous or somewhat viscid-pubescent: leaves ovate or oblong in outline, 1–2′ long, shorter than the petioles, pinnately 3-foliate; upper leaflet 3-lobed, the lower 2-lobed and sessile, lobes sparingly incised; peduncle exceeding the leaves; umbel naked, unequally 4–8-rayed; involucels foliaceous and unilateral, the 4–8 very unequal segments oblong, acute or obtuse, mostly exceeding the flowers; calyx-teeth ovate to linear-lanceolate, acute; petals yellow; disk broad; fruit glabrous, ovate, exceeding the short pedicels.—Remarkable for its conspicuous foliaceous involucels. Fruit immature, but sufficiently grown to show its character. New Mexico (Dr. Newberry, on the Mexican Boundary Survey); Northern Arizona, on stony soil (Mrs. E. P. Thompson). April.

ANGELICA WHEELERI.—Tall and stout, roughly puberulent; leaves biternate; leaflets ovate-oblong, 2–3′ long, acute, incisely serrate, the teeth broad and mucronulate, middle leaflet petiolulate; involucre and involucels none; rays numerous, unequal, becoming 2–5′ long; pedicels and ovary hispid; petals apparently white; fruit broad-elliptical, 3″ long, subpubescent, the dorsal wings thick, narrower than the lateral ones.—Utah (Wheeler).

GARRYA FLAVESCENS. (*Garrya* ——?, Watson, *King's Rep.* 5, 421).—Pubescence silky, appressed; leaves elliptic-oblong, 1–2½′ long, acute at each end, entire, glabrate above, margin revolute; petioles 3–6″ long; aments pendulous; bracts 6–10 pairs, broad-ovate, connate, foliaceous, acute or the lower acuminate; sterile aments 1–2′ long, loose, the flowers (1–3 together) on pedicels equaling or exceeding the bracts; fertile aments 1′ long, dense, with solitary flowers and densely pubescent fruit.—Frequent from Southern Nevada and Utah to Arizona and New Mexico; growing 5–8° high, and flowering in March.

BRICKELLIA (CLAVIGERA) LONGIFOLIA.—Slightly scabrous, very slender, with spreading branches; leaves 2–5′ long, linear, acuminate, entire or obscurely sinuate-toothed, flat with scabrous margins, 3-nerved, punctulate; flowers on short slender pedicels, axillary and in small terminal clusters; involucre glabrous, 2″ long, the spreading scales acutish, or the linear inner ones obtuse or truncate; achenium 10-striate, slightly and minutely hairy on the angles, nearly 1″ long, the soft minutely barbulate pappus but little longer.—Southern Nevada (Wheeler); Northern Arizona (Mrs. E. P. Thompson). In a damp cañon; April.

HAPLOPAPPUS CERVINUS.—Low, 6′ high, suffruticose, resinous-scabrous, the short herbaceous stems leafy to the top; leaves oblong-lanceolate, 4–6″ long, shortly cuspidate, attenuate to the base, entire, subscabrous, 3-nerved; heads 3–4″ long, in 3–5-flowered terminal corymbs; outer scales linear, acuminate, with setaceous spreading tips, the inner chartaceous, acutish, with scarious lacerated margins, erect, nearly equaling the pappus; rays few, narrow and short; style exserted; achenia linear, pubescent.—Nearest to *H. suffruticosus*, Gray. Antelope Cañon, Utah (Wheeler).

LAPHAMIA MEGALOCEPHALA.—Scabrous-pubescent; stems diffusely branched, 1° high; branches simple; leaves alternate, broadly ovate, 2–3″ long, smaller upon the branches, entire, very shortly petioled; heads large, 2–3″ in diameter, terminal and solitary, discoid, many-flowered; achenia compressed, hispid; pappus none.—With nearly the habit of *L. Stansburii*, Torr. Nevada (Wheeler).

VIGUIERA RETICULATA.—White-tomentose; stems herbaceous; leaves subopposite, coriaceous and rigid, broad-ovate, 1–2′ long, cordate at base, acute, entire, shortly petioled, strongly reticulated beneath; bracts small, lanceolate; heads 4–5 together in short close corymbs; involucral scales imbricated in 3–4 series, lanceolate, thick, appressed or with spreading tips; rays entire; receptacle shortly conical; chaff acutish; achenia silky, the pappus-awns subulate at base, the scales lacerate.—Telescope Mountain, Southeastern California (Wheeler).

CHÆTADELPHA * WHEELERI, Gray MS.—Stems numerous, 1° high, flexuous; leaves

*CHÆTADELPHA, Gray MS. (New Genus of *Cichoraceæ*). Heads about 5-flowered. Involucre cylindrical, of 5 linear 1-nerved scales in a single row and several small imbricated scales at base. Receptacle naked. Ligules short. Achenia linear, glabrous, 5-angled, somewhat striate between the prominent angles, slightly thickened upward. Pappus of a single row of

linear-lanceolate, 1-2' long, acute, entire, rather rigid; flowers apparently rose-color; involucre 6'' long, shorter than the brownish pappus; achenia 3-4'' long.—With the habit of *Lygodesmia juncea*. Southern Nevada (Wheeler).

GILIA (NAVARRETIA) DEBILIS,— Slender, 1-2' high, leafy above; pubescence minute or hirsute; leaves alternate, ½-1' long, oblong, attenuate into a short petiole, entire, or some of them broader and 3-lobed; bracts entire, resembling the leaves, twice longer than the calyx; flowers nearly sessile; calyx-teeth ovate-triangular, shorter than the tube; corolla funnel-form, 8'' long, with elongated tube and deeply lobed limb, light-purple; the stamens upon the throat, exserted; capsule 1'' long, the cells 1-seeded; seeds without mucilage or spiracles.—Utah (Wheeler). Without the pinnatifid pungent lobing of the leaves and bracts which is usual in the section.

CONVOLVULUS LONGIPES.— Glabrous, glaucous, twining; leaves linear, 1' long or less, entire or auricled at base, petioled; peduncles elongated, 2-6' long, mostly strict, 2-3-bracted, usually 1-flowered; bracts linear; calyx-lobes rounded, obtuse or emarginate; corolla funnel form, 1¼' long, yellowish.— Southern Nevada (Wheeler).

FRAXINUS CORIACEA.— Leaflets 3-5, coriaceous, obovate or oblong, 1-2' long, truncate or rounded at the apex or acutish, attenuate or abruptly contracted at base, sparingly toothed, mostly rather long-petiolulate, glabrous, or with the petioles pubescent when young; fruit 1' long, terete at base, widening into an oblong obtuse wing; calyx persistent.—Ash Meadows, Nevada (Wheeler), and Devil's Run Cañon, Arizona (Bigelow), on the Mexican Boundary Survey.

OXYBAPHUS GLABER.—Glabrous; panicle large and open; bract-leaves oblong, sessile; flowers solitary, on slender pedicels 2-3'' long, becoming deflexed; involucre 1-flowered; calyx shorter than the involucre; fruit glabrous, oblong, strongly tuberculate between the prominent ribs.— Lower leaves not collected but the species is otherwise strongly marked; fruit much as in *O. glabrifolius*. Kanab, Utah (Mrs. E. P. Thompson). In dry soil; October.

ABRONIA VILLOSA.—Pubescence more or less densely villous, subglandular, spreading; stems weak and slender; leaves ½-1' long, oblong or ovate, obtuse or acutish, attenuate into a slender petiole; heads 5-10-flowered; involucral scales narrowly lanceolate, long-acuminate, 3-4'' long; flowers pink, the lobes obcordate with a deep sinus; fruit with a firm body, strongly reticulate-pitted, the 3-5 broad wings consisting of a simple lamina, usually truncate above.— Nearest to *A. umbellata*. Arizona (Wheeler).

ERIOGONUM THOMPSONÆ. (§ *Corymbosa*).— Branches short, subwoody, ascending, leafy, bearing a long naked peduncle; stem, petioles and under surface of the leaves white-tomentose, otherwise glabrous; leaves broad-oblong, 1½' long, acute at each end, long-petioled; scape 1° high, rigid, repeatedly trichotomous above, and tribracteate at the nodes; involucre 5-toothed and strongly 5-angled; flowers yellow, naked, the segments of the perigonium nearly equal.—Whole plant yellowish. Sand-cliffs near Kanab, Utah (Mrs. E. P. Thompson). September.

QUERCUS UNDULATA, Torr.— The common low oak of the Rocky Mountains and Wahsatch, ranging southward to New Mexico and Southern Utah. An examination of considerable material shows that it is quite variable in its foliage and includes several reputed species and forms. The typical form has oblong leaves with acute or acutish entire divaricate mostly triangular lobes, the sinuses reaching half-way to the midrib. This is also *Q. Fendléri*, Liebm. With large leaves and the lobes sometimes coarsely notched it becomes *Q. Gambellii*, Nutt., and *Q. Douglasii*, var. *Neo-Mexicana*, A. DC. With the lobes more obtuse it is *Q. alba*, var. (?) *Gunnisoni*, Torr.; and with the lobes less divaricate and more oblong, frequently notched at the apex, and the rounded or narrow sinuses reaching often nearly to the midrib, it is the more prevalent northern form, *Q. obtusiloba*, var. *depressa*, Nutt., and var. *Utahensis*, A. DC. The extreme states appear quite distinct, but intermediate forms abound and there seems to be nothing in the flowers or fruit to distinguish them.

SALIX NEVADENSIS.—Aments short, 6-8'' long, appearing with the leaves, ascending on leafy peduncles; scales oblong, obtuse, glabrous, or subsilky in the male aments, light-colored; stamens 3, free; capsules glabrous even when young, on pedi-

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barbulate bristles, those at the angles stout and rigid, the few intermediate ones shorter, capillary and more or less united to them.—A smooth, diffusely branched, herbaceous perennial, with alternate leaves and solitary terminal flowers.

cels ½'' long; style none; stigmas short and thick; leaves lance-linear, ½-1' long on flowering specimens, acuminate, entire, silky-tomentose; stipules very minute.—A slender shrub, 3-4° high, with light-colored bark and yellowish foliage, growing in dry sandy soil. It differs from *S. Hindsiana* in its more reduced habit, its silvery pubescence, narrower, more scarious, lighter-colored and glabrous scales, more slender and smoother capsules, and thicker and shorter stigmas. At the base of the Washoe Mts., near Carson City (1093 Watson), and in Central Nevada (Wheeler).

CALOCHORTUS AUREUS.—Low, 4-6' high, with a single linear carinate radical leaf, 3-4' long; scape short, 1-2-flowered, the single pair of bracts linear, 2' long; sepals greenish-yellow, with a dark-purple spot near the base, oblong- or ovate-lanceolate; petals broadly cuneate, 15'' long, bright-yellow, with a small well-defined circular densely hairy gland near the base and a lunate purplish spot above it; young capsule narrowly oblong, not winged.—On sand-cliffs, Southern Utah (Mrs. E. P. Thompson); June.

CALOCHORTUS FLEXUOSUS.—Branched and flexuous above; bracts alternate, ½-1½' long, linear-lanceolate, carinate, rather rigid; sepals oblong-lanceolate, greenish with a deep-purple and orange spot at base; petals broadly cuneate, 12-15'' long, purplish, with a deep-purple claw and an ill-defined circular orange or purple gland above, the glandular hairs extending laterally to the margin; capsule triangular, narrowly oblong.—Southern Utah and Northern Arizona (Mrs. E. P. Thompson); April and May. The bulbs, as of other species, are eaten by the Indians.

ANDROSTEPHIUM BREVIFLORUM.—Scapes 6' high; umbels 4-7-flowered, the pedicels 6-15'' long; perianth violet, 6-7' long, the nearly erect lanceolate segments equaling the campanulate tube; corona 3'' long; capsule triangular-globose, 3'' in diameter.—A stouter plant than *A. violaceum*, with much smaller flowers. Southern Utah and Northern Arizona (Mrs. E. P. Thompson); April and May. Bulbs also eaten.

# ON THE DATES OF PROFESSOR COPE'S RECENT PUBLICATIONS.*

BY PROF. O. C. MARSH.

DURING the past year Dr. Leidy, Prof. Cope, and myself have been investigating the fossil vertebrates of the Eocene of Wyoming, and our material has not unfrequently included the same species. Our descriptions have usually been published as separate papers, issued in advance of the journals containing them. To prevent, if possible, any question about priority of publication I agreed with each of these authors in March, 1872, that we should send to each other, on the day of publication, any papers on the above subject we might issue, the date of publication to be either printed or written on each pamphlet. This would ordinarily secure the receipt of the papers on the following day, and we agreed to accept this receipt, so far as we were individually concerned, as

* Communicated to the Philadelphia Academy of Natural Sciences, April 8th, 1873.

publication. This agreement Dr. Leidy has scrupulously observed, and I have myself carefully kept it.

Between July 22d and October 8th, 1872, I published a series of fourteen papers on vertebrate fossils from the West, and in every instance mailed copies to Prof. Cope and Dr. Leidy on the day of publication, and, of the more important papers, a second copy by a subsequent mail, as we had also agreed. Believing, with most naturalists, that publication of a paper by means of advance copies can be fairly done only by making these copies accessible to those working in the same department, I likewise sent copies of each of my papers, on the day of publication, to the principal scientific centres in this country which are especially interested in this subject, namely: Professor Baird of the Smithsonian Institution; the Museum of Comparative Zoology in Cambridge; the Boston Society of Natural History; the editors of the American Naturalist; the editors of the American Journal of Science; the Academy of Natural Sciences in Philadelphia and the American Philosophical Society. I also promptly placed these pamphlets on sale at the Naturalists' Agency in Salem, and sent early copies to palæontologists in Europe, and to various scientific journals. That these papers were duly received, the records of the above societies, and the reviews and notices in several periodicals, as well as letters from correspondents, afford ample testimony. The papers subsequently appeared in successive numbers of the American Journal of Science, from August to November, 1872.*

During this period of over three months, in which these various papers were being published, I received nothing of the kind from Prof. Cope. An intimation from a friend finally led me to think that this author might, perhaps, have published something which had accidentally failed to reach me, and, as it was important to have this settled, I made inquiries at each of the above points in this country where I had sent my papers, and soon ascertained definitely, that no publications by Prof. Cope, issued subsequent to July 1st, 1872, had been received. The inquiry was diligently extended, also, among American naturalists, especially those who would be most likely to know of such publications, but no evidence of a single copy could be obtained. This was the case up to October 8th, 1872, when the last paper of my series was published, and I started for the West.

* Vol. IV. pp. 122, 202, 256, 298, 322, 323, 343, 344, 405 and 406.

About a month after this, or November 5th, 1872, five papers by Prof. Cope were received at New Haven, and, on the 11th of that month, five more, which were all forwarded to me at Cheyenne, Wy. A third lot reached New Haven, December 4th, 1872, and was given to me on my return a few days later. In these various papers, which were mostly uncorrected proofs, several genera and species, which I had described three months before, are re-named by Prof. Cope. The papers, moreover, bear dates from July 11th to October 12th, 1872, and thus might appear to anticipate part of my descriptions, in some cases only by a single day. These papers purport to have been read before the American Philosophical Society, but the official records of that Society show that they were not even presented until long after the dates claimed for them. They have since appeared in the Proceedings of that Society, Number 89 * (published February 6th, 1873), more than three months after my last paper had appeared in the American Journal of Science.

On learning of the distribution of these papers by Prof. Cope, I renewed my inquiries about their true dates of publication, and found that copies were first received, October 29th, 1872, by the Philadelphia Academy of Natural Sciences, of which Prof. Cope is secretary, and that apparently none were distributed at an earlier date. Wishing, if possible, to avoid bringing this matter into public notice, I informed Prof. Cope, personally, that I could find no evidence of any copies of his papers being distributed before October 29th, 1872, and requested him, if he claimed an earlier publication, to inform me where any of these papers had been sent. He at first declined to do this, but finally mentioned five addresses in this country and Europe, to which the papers in question had been duly forwarded, during his absence, by the person entrusted with their distribution. I have since learned from two of these places that nothing definite is known of these papers, and from the other three I have a positive assurance that none of them were received.

It thus becomes evident that these papers by Prof. Cope were not published at the time claimed, and I protest against the dates they bear being accepted as authentic. Publication of scientific results means *making them known*, especially to those interested, and cannot be claimed where these results are so carefully withheld

* Vol. XII, pp. 460, 466, 469, 472, 478, 481, 483 487, 542, 554 and 580.

that no record of them can be found by diligent inquiry. The few species at stake in the present case are comparatively of little consequence, but the principle involved is all important, and if disregarded, scientific nomenclature will become worthless, and honest research lose its just reward.

## TINOCERAS AND ITS ALLIES.

BY PROFESSOR O. C. MARSH.

SINCE the article on page 217 of the April NATURALIST was printed, another pamphlet by Prof. Cope on the same subject has been received (March 20th). In this paper, which is dated March 14th, 1873, and illustrated by four plates, Prof. Cope has at last adopted nearly all my views as to the characters and affinities of the *Dinocerata*, as well as most of my corrections of his errors, although without giving credit in either case. Unfortunately, he still misinterprets the structure of this group on several points, and most of his dates are incorrect as before. On nearly every page of the paper, moreover, new errors may be detected, a few only of which can be corrected here, for want of space.

1st. Prof. Cope is wrong in assigning only three sacral vertebræ to the *Dinocerata*, as *Dinoceras*, the type of the group, certainly has four, and the other genera probably as many. 2d. The neck in *Tinoceras grandis* Marsh (or ? *Tinoceras cornutus*) was much more than a foot in length, rather than less, as the cervicals in the Yale Museum clearly prove. 3d. Prof. Cope is entirely in error in saying that the muzzle in this species could not reach the ground by several feet; the animal really having no use for the long proboscis which Prof. Cope persists in putting on him. 4th. The specimen described as *Eobasileus cornutus* was fully adult, as the teeth show, and the differences between it and the type of *Tinoceras grandis* may be due to age. 5th. The nasal bones in this genus do not form the inner half of the middle horn-cores, but only a small portion of the base, the cores being essentially on the maxillaries. 6th. The anterior extension of the malar bone is not in *Dinoceras* much less than in Perissodactyls. 7th. The

tusks figured in plate I of Prof. Cope's paper are not in their true position, and in plate II the left tusk is placed on the right side, thus entirely reversing its characters. 8th. The name *Loxolophodon* was not applied to the genus *Tinoceras*, Aug. 19th, 1872, but long afterward, and then altered to *Lefalophodon*, with specific names all different from those now claimed. A good example of the inaccuracy which seems inseparable from Prof. Cope's work is seen in the explanation of the plates of this paper, where two serious mistakes occur in the first line.

Prof. Cope concludes with some remarks about nomenclature, evidently aiming to save, if possible, some of his names which are anticipated by mine. His views as to what constitutes publication are absurd, and would not be accepted by any scientific authority. His precepts about describing genera may be fitly compared with his practice, without going beyond the *Dinocerata*. The name *Loxolophodon* Cope was first given, without description, to a genus which Prof. Cope now rejects, and when again applied, contrary to usage, to the genus *Tinoceras*, all the generic characters mentioned existed only in that author's imagination.

In a late number of "Nature" (February 27th, Vol. VII, p. 335), there is a report, written by Prof. Cope, of various meetings of the American Philosophical Society. This report, which was unauthorized by the society, contains several important misstatements. Under the meeting of August 16th, 1872, it is stated that "A communication from Prof. Cope was read on his discovery of '*Proboscidia* in the Wyoming Eocene,' * * * a new genus, *Eobasileus*, was described." The official records of this society show that no paper with this title, or on this subject was read at this meeting, and none was even presented until more than a month later, or September 20th. This misstatement is a serious one, since it is likely to mislead European naturalists as to the paper thus antedated. The description of "*Eobasileus*" as quoted in this report is quite different from that given in the paper when read, or as since published (February 6th, 1873), in the Proceedings of the Society, Vol. XII, p. 485. This makes at least the sixth time this genus has been antedated, and its supposed characters changed by Prof. Cope within as many months.

A circular has lately been issued by Prof. Cope requesting signatures from those who received his papers, the dates of which I have questioned. This circular quotes from my note on page 151,

but the quotation is incorrect, and conveys a very different meaning from the original. A signature to this circular can have no weight in the present discussion, as the document is so worded that it calls for no definite information whatever in regard to the real date of publication of any one of the doubtful papers. In this respect, and in its inaccuracy, the circular resembles perfectly Prof. Cope's other publications which I have recently criticised.

## REVIEWS AND BOOK NOTICES.

A Text-book of North American Ornithology. — Suitable manuals of zoology, treating of single classes of animals, have hitherto been desiderata in our zoological literature. The subject of the present brief notice — Dr. Elliott Coues' "Key to North American Birds"* — is a work unique in its conception, and the first of a kind one may well hope to see soon supplied for each class of our native animals, and especially for the several classes of the vertebrates. In these classes the number of species is small in comparison with the number of species of insects and of plants, and can be readily comprised in a volume of convenient size for a hand-book. Gray's admirable series of botanical text-books furnish guides to our flora that render accessible to the ordinary student and amateur a general knowledge of our plants, but until now we have had no similar handbook for any department of zoology.

The character of Dr. Coues' work, so far as fidelity of treatment and scientific accuracy are concerned, is sufficiently endorsed by the high character of his various special memoirs and monographs, and his high standing as an original investigator. The value of his "Key" as a text-book of American ornithology may be regarded as two-fold; first, its clear exposition of the latest and most generally approved views of the subject treated, and, secondly, its scope and the arrangement of the subject matter itself. A general "Introduction" treats of the leading principles of ornithology, and describes in detail, aided by suitable illustrations, the external

*Key to North American Birds, containing a concise account of every species of Living and Fossil Bird at present known from the Continent north of the Mexican and United States Boundary. Illustrated by 6 Steel Plates and upwards of 250 Woodcuts. By Elliott Coues, Assist. Surg. U.S. Army. Salem: Naturalists' Agency; New York, Dodd & Mead; Boston, Estes & Lauriat, 1872.

parts and organs of the bird, with full explanations of the technical terms used in descriptive ornithology. This is followed by a "Key" or artificial analysis of the genera of North American birds, similar in plan to the artificial analytical tables employed in botanical manuals as a guide to the families of plants. The student being fitted to intelligently use the "Key," by a careful study of the "Introduction" which precedes it, the "Key" enables him without previous special acquaintance with the subject, to find the name of any species of bird occurring in North America, north of Mexico, he may chance to have. In the "Synopsis" which follows the "Key," and which forms the chief bulk of the volume, are given concise, admirably clear diagnoses of the species and varieties of our birds, with indications of their geographical range. The higher groups are also quite fully and satisfactorily characterized, including the exotic as well as the indigenous forms; and the classification adopted is probably the one most generally approved by leading ornithologists. The diagnoses are illustrated by upwards of two hundred figures of such parts as are most useful in classification. Following the general synopsis of the living forms, is a concise account of the fossil species, twenty-nine in number, which has the great merit not only of being the work of the highest authority on the subject, but of being the first and only general exposition of this department of American ornithology.

While, perhaps, not above criticism in respect to occasional minor details, it is a work not only especially designed for students and amateur ornithologists, but one well calculated to meet the end in view, and as such entitles the author to the gratitude of all beginners and even somewhat advanced students of American ornithology.—J. A. A.

## BOTANY.

A BLUE ANAGALLIS.—Dr. Gray recognizes the fact that *Anagallis arvensis* L., occurs sometimes not only with purple and even white flowers, but also with blue ones. Of course it is well known to restrict itself, usually, to a rather peculiar red. I have this season found near my house a vigorous plant bearing flowers of most beautiful and decided blue, which is the first instance within my observation. I would like to know how common this form is, and whether it is not a singular characteristic that one species should thus exhibit two of the primary colors, as I remember no other

such case except in shrubs induced by cultivation. I am unable to detect in the plant before me any difference from the common form, unless, perhaps, less pointed petals and somewhat narrower leaves.— C. M. TRACY, *Lynn, Mass.*

EPIGÆA REPENS.—This plant deserves a more careful examination than it has yet received. The infrequency of the occurrence of fruit has been explained in different ways, but no satisfactory explanation has yet been offered. In the "Botanical Register," vol. 3, p. 201, the following statement occurs:—"Some of the corollas are frequently found to be sterile; and, according to Michaux, it would appear that the species was diœcious, the flowers being sometimes barren throughout in individual plants." Mr. Meehan has called attention to the great degree of variation which occurs in many of our native wild plants, this among the number, and it is to be earnestly hoped that our botanists will commence early to make more critical observations respecting variations in such cases. A series of carefully conducted experiments in regard to the cross fertilization of Epigæa is much needed. Owing to the great facility with which such experiments can be performed, we are confident that some of our readers will take the matter in hand.

DIMORPHIC FLOWERS OF THE IPECAC PLANT.—Prof. Balfour of Edinburgh has given to the Royal Society of Edinburgh, a very interesting account of dimorphism in the flowers of *Cephaëlis Ipecacuanha.* The plants in the Edinburgh Botanical Garden were derived from two sources; in one case the flowers have long stamens and short styles. In the other case there is distinct dimorphism. Some of the flowers have long stamens and a short style; others short stamens and a long style. Successful fertilization has followed the application of the pollen from one form to the stigmas of the other form. It will be remembered that this plant belongs to the order *Rubiaceæ.* This order gives us one of the very best common instances of dimorphism, *Houstonia cœrulea,* clearly described in Dr. Gray's "How Plants Behave."

IODINE IN THE DETERMINATION OF FUNGI.— Some of our readers are acquainted with the use of chemical re-agents made by Nylander in the study of lichens. This application has led to the idea that a similar use of chemical tests may be adopted in the determination of fungi. In the Feb. (1873) number of the "Journal

of Botany," Mr. Phillips gives some facts respecting the employment of tincture of iodine for this purpose. The re-agent used is the common tincture of iodine, diluted to one-half with alcohol.

A drop of this is placed on a glass slide with a thin section of the hymenium and subjected to a slight pressure, under a magnifying power of 300–400 diameters. The blue-purple or purple-black color which appears in the investigation of some *Pezizas*, appears to be specifically characteristic. Thus *Peziza melaloma* A. S., no reaction. *P. badia* P., summits of asci pale blue. *P. repanda* Wahl., apices of asci blue. *P. trechispora* B. and Br., tips of paraphyses deep purple-blue. *P. vitellina* Pers., tips of paraphyses deep purple-black.

It may be worthy of note that owing to the blue color obtained in 1858, by Mr. F. Curry, in the examination of a species of *Tuber*, the name *Amylocarpus* was given as a generic appellation.

A NEW FLY-TRAP.— Professor A. Braun, in a communication to a Botanical Society, has briefly described a new form of vegetable fly-trap. (Botan. Zeitung, Sept. 20, 1872). The plant referred to is an East Indian Papilionacea, *Desmodium triquetrum* DC.

The simple leaf with a margined petiole feels rough to the touch, and remains hanging lightly to the finger which has touched it. Little flies, which alight on the leaf, are held by an invisible power and die after ineffectual struggles to free themselves from it. One can often see six or eight flies fastened in this way to the upper surface of the blade; less often, and more widely scattered, on the underside. The hairs which act thus are distributed over the whole surface and appear to the naked eye as scarcely noticeable white points: they are not over 0·08–0·10 millimetres long, and 0·01 millimetres thick, and consist of two cells. The under cell is one-fourth of the whole length. The upper cell is pointed like a fish-hook with a sharp barb. These acute angles, invisible without a lens, are what fasten the insect down.

Beside the angled hairs there are others on the leaf. They are found especially on the nerves, and have a much more appreciable length and thickness (0·50 and 0·01 millimetres), they are unicellular, blunt, and on the upper surface beset with little projections.

## ZOOLOGY.

A FOUR-LEGGED ROCK LARK.— On November 23rd, while walking on the seashore in the vicinity of Plymouth, I saw the most

extraordinary *lusus naturæ* in the shape of a rock lark (*Anthus petrosus*) that I ever saw in my life. It had four legs and no tail (at least where the tail should have been), but that appendage was placed just above the left eye, and sticking out behind like a long depressed crest, — indeed it was a perfect "nightmare" of a bird, such a one as you might dream about — the extra legs were dangling from the extremity of its body. It was feeding on a heap of decayed seaweed on the shore. Unfortunately, I had no gun with me or I could have shot it a hundred times over, but as I had a field glass with me I could examine it as distinctly as though I had had it in my hand. The next day I returned to the spot with my gun and had a shot at it at once, but the gun "hanging fire" I did not quite kill it, and some children running to the spot before I could load again, it managed to flit away where I could not see it.

A "lusus" is not so wonderful in a bird just hatched, but seldom lives long, whereas this was a lively full-grown rock lark.—J. Gatcombe, *Plymouth, England.*

Births of Animals in the Central Park Menagerie.—Puma (*Felis concolor*). Two cubs were born August 24, 1872; period of gestation, thirteen weeks; spotted; born blind, eyes open on the eighth day; very playful. The puma has seldom more than two at a birth.

Leopard (*Felis leopardus*). Two cubs were born October 28, 1872; period of gestation, thirteen weeks; markings similar to that of the mother; born blind, eyes open on the eighth day.

Spotted Hyæna (*Hyæna crocuta*). Two cubs were born, one January 5, 1873, the other twenty-four hours after; covered with a soft hair half an inch long, of a uniformly black color, no indication of spots; born with eyes open. Weight of cub, $3\frac{1}{4}$ pounds, length from nose to tip of tail $22\frac{1}{2}$ inches; tail slender and tapering; height at shoulder 9 inches; canines $\frac{2}{2}$, incisors $\frac{6}{6}$; conch of ears lying flat to the head; bald internally, outside covered with hair. Supposed to be the first hyæna bred in this country.

Camel (*Camelus dromedarius*). One calf was born January 16, 1873; period of gestation, twelve months, in this case twelve and a half months. About three hours after birth the calf was held up to suckle, the next day was able to get on its feet and nurse itself.—N. A. Conklin, *Director Central Park Menagerie.*

Canaries and Hyacinths.—A lady visitor remarked that one

of our canaries had a bad cold, her quick ear having detected a wheezing sound like that of a catarrh. It had continued already for several days. Being myself very unpleasantly affected by the odor of some flowers, I guessed the cause to be the contiguity of the hyacinths growing in glasses, and now filling the room with perfume. These flowers, which were close to the cage of the sick bird, were now taken from the room and the bird showed immediate relief, and in a day was well.— S. LOCKWOOD, *February* 14.

PHOSPHORESCENCE. — Professor Panceri, of the University of Naples, has just published a memoir on this highly interesting subject, in the fifth volume of the *Atti della Reale Accademia delle Scienze fisiche e matematiche*, 1871, under the title "Gli Organi luminosi e la Luce delle Pennatule." It consists of two parts, one anatomical, the other physiological. He notes the existence of special organs which have the power and apparently the function of producing phosphorescent light, and finds that the light is only emitted by the polyps and the zooids, while the phosphorescent organs, as he terms them, consist of eight "cordoni luminosi," which are attached to the outside of the stomach of the polyps and zooids, and are prolonged in each case as far as their mouth-papillæ. These threads (cordoni) are principally composed of a tissue built up of vesicles or cells and possessing all the characters of fat; albuminoid cells are likewise met with in it. This fatty matter generates light, not only by the direct excitation of the polyps and the zooids themselves, but by excitation of the whole trunk of the Pennatula. In the latter case the author has made the remarkable discovery that the progress of the light developed in succession over the several parts of a polyp gave a striking indication of the direction, progress, and rapidity of the excitation applied to the Pennatula, and he has found these latter calculable, a fact of the greatest interest to physiologists. Professor Panceri further states that the phosphorescent substance produces light, after its removal from the body of the polyp, if subjected to mechanical treatment such as friction and compression, or the action of chemical agents, electricity or heat. And this is the case when the substance is extracted, not only from the living animal, but some short time after its death. The author, in his earlier investigations of the phosphorescence of other fatty

substances, considered the phenomenon due to their slow oxydation. He believes this holds good in the case of the "cordoni luminosi" of the Pennatula, and thinks it to a certain amount subject to the voluntary powers of the animal. He found similar phosphorescent substances in the epithelium of Medusae, and in Pholas he saw two distinct organs inside the mantle which are furnished with the power of becoming luminous. Some Chætopteri, Beroe and Pyrosoma were likewise examined, and a great similarity noticed in all these cases as regards the constitution of the phosphorescent substance. In the spectroscope the light exhibits one broad band like that given by monochromatic light, while, as is well known the phosphorescent light of *Lampyris* and *Luciola* is polychromatic.— *The Academy.*

THE GAME BIRDS OF THE NORTHWEST.—The game birds of the northwest seem in a fair way to be thoroughly looked up. We notice a circular from Dr. Coues, published by command of General Terry, of the Department of Dakota, inviting the coöperation of all army officers serving in the Department, in the work of ascertaining the precise geographical distribution of feathered game, their times of arrival and departure, breeding resorts, habits, etc. This is to be incorporated in a report on the "Ornithology of the Northwest," to be published by the Department of the Interior, and forming one of the series issued by the U. S. Geological Survey of the Territories, in charge of Dr. F. V. Hayden. The undersigned respectfully solicits the coöperation of those of his brother officers who may be interested in a certain portion of his work.

With their friendly assistance, he hopes to largely increase, and render more precise, our present knowledge of the *Game Birds* inhabiting the region drained by the Missouri river and its tributaries. Under this head are included:

1. *Grouse* of several different species: the sharp-tailed grouse, or "chicken;" the pinnated grouse, or prairie-hen; the ruffed grouse, or "partridge;" the dusky or "mountain" grouse; the ptarmigan, or "snow" grouse; the sage-cock, cock-of-the-plains, and the quail.

2. *Wading Birds* of various kinds: wood-cock, snipe, plover, curlew and allied species.

3. *Water Fowls* of all sorts: swans, geese and ducks.

He desires to ascertain, with entire precision, the geographical

distribution of the resident species, the times of arrival and departure of the migrants, and the localities to which the summer visitants resort to breed.

It is hardly necessary to add, that each contribution to the forthcoming report would be accredited to its proper source. In order to be available for the object in view, manuscripts should be received not later than June next.—*Address* DR. E. COUES, U. S. A., *Fort Randall, Dakota Territory.*

## GEOLOGY.

ON THE TUSK OF LOXOLOPHODON CORNUTUS.— Professor Marsh asserts that I have reversed the positions of the tusks of this species, placing that of the left side on the right, etc. This statement is not true, as I have carefully distinguished the sides in my description (Short-footed Ungulata, etc., p. 10). In my plate 2d the inner side is not represented as the outer, as the inner surfaces of attrition are omitted, and the external represented. Like his other charges this one results from a misapprehension. Having seen a photograph in which, for the assistance of the artist, the left tusk was taken on the right side, he at once concludes that my lithograph represents it in the same position.— E. D. COPE.

## ANTHROPOLOGY.

EXISTENCE OF MAN IN THE MIOCENE.— I have received a letter from Mr. Edmund Calvert, in which he informs me that his brother, Mr. Frank Calvert, has recently discovered, near the Dardanelles, what he regards as conclusive evidence of the existence of man during the Miocene period. Mr. Calvert had previously sent me some drawings of bones and shells from the strata in question, which Mr. Busk and Mr. Gwyn Jeffreys were good enough to examine for me. He has now met with a fragment of a bone, probably belonging either to the Dinotherium or a Mastodon, on the convex side of which is engraved a representation of a horned quadruped, "with arched neck, lozenge-shaped chest, long body, straight fore legs and broad feet." There are also, he says, traces of seven or eight other figures, which, however, are nearly obliterated. He informs me that in the same stratum he has also found a flint flake, and several bones broken as if for the extraction of marrow.

This discovery would not only prove the existence of man in Miocene times, but of man who had already made some progress, at least, in art. Mr. Calvert assures me that he feels no doubt whatever as to the geological age of the stratum from which these specimens were obtained.

Of course I am not in a position myself to express any opinion on the subject; but I am sure that the statements of so competent an observer as Mr. Calvert will interest your readers.—SIR JOHN LUBBOCK, *in "Nature."*

## MICROSCOPY.

AMPHIPLEURA PELLUCIDA IN DOTS.—A $\frac{1}{50}$ objective was made by Tolles to my order and finished on the 12th of March, 1873. The angle of aperture as invoiced by Mr. Stodder is 165°. From my measurements I think the objective is correctly named by the maker. At the extreme open point it is a good $\frac{1}{40}$ dry. The screw-collar has twelve divisions: by turning it eight divisions it is adjusted for uncovered wet, and four divisions remain to adjust for cover for immersion work. It works through covering glass of about $\frac{1}{200}$ of an inch; but it is better to use thinner glass, or mica, to enable the observer to focus through specimens.

With lamplight and the $\frac{1}{50}$ the resolution of *Amphipleura pellucida* is better than I have before seen. Using ordinary daylight *Vibriones*, *Bacteria*, etc., are well defined, especially when a Kelner eye-piece is used as a condenser.

With sunlight and the ammonia-sulphate of copper cell, *Surirella gemma* yields longitudinal striæ, and, as the direction of the light is changed, rows of "hemispherical bosses" as described by Dr. Woodward.

With the same illumination specimens of *Amphipleura pellucida*, mounted dry, by Norman, were resolved and counted with perfect ease and remarkable plainness, the striæ being still distinctly visible with No. 3 eye-piece, draw-tube extended six inches and power upwards of 10,000 times. It is with hesitation that I remark further that the $\frac{1}{50}$ has resolved the lines of *Amphipleura pellucida* into rows of dots, for the "beaded" structure of the easier test, *Surirella gemma*, is still doubted by some experienced microscopists. But facts are stubborn things, and the facts are that with Wenham's parabola as an illuminator the dots are seen, and with either the paraboloid or the Amici prism longitudinal lines much

finer than the transverse ones are brought out. These lines, which I consider genuine, count not far from 120,000 to the inch. With a slight change of the adjustment their place is occupied by spurious lines counting generally about 60,000 to the inch. The longitudinal lines can only be seen when the focus is best adjusted for the transverse striæ. When the transverse lines are examined, they may be shown smooth and shining, similar to the photograph by Dr. Woodward in the NATURALIST, but much better. If the mirror is then carefully touched a sinuate appearance of the margins of the lines, suggestive of beading, is seen. This appearance can be brought out readily. And, finally, after the most painstaking manipulation, and when without doubt the best work is being done, the separated dots or beads appear.—G. W. MOREHOUSE.

## NOTES.

ON the 21st of April Mr. Anderson formally presented the island of Penekese, together with a fund of $50,000 for the endowment of a School of Natural History. The board of trustees of the school and fund is in part the same as that governing the Museum of Comparative Zoology at Cambridge, of which this school is to be the educational branch. Plans have been drawn for two two-story buildings, each one hundred feet long and twenty-five feet wide. The lower floors are intended for laboratories and working rooms. The second story will contain sleeping rooms, and rooms for the preservation of specimens. The deed makes Professor Agassiz president of the board of trustees and director of the school, with the sole control of the method of instruction, and the appointment of teachers. The school will be called "The Anderson School of Natural History," and will be opened early in July.

FROM want of space we have been unable to adequately notice the remarks made at the banquet lately given in New York to Professor Tyndall just before he sailed for England. Many of the leading scientists of the country, with those eminent in all professions in New York, met him at Delmonico's. Perhaps this is the first occasion of the sort when in this country science has, through her followers and through those engaged in quite different pursuits, received due consideration. The after dinner speeches, with one or two exceptions, were animated with the true spirit of devotion to truth, which is but another term for the scientific spirit.

The burden of Professor Tyndall's admirable and delightful speech was the importance of producing trained original investigators. He had alluded to this before in his sixth and concluding lecture, where he says,—

"When analysed, what are industrial America and industrial England? If you can tolerate freedom of speech on my part, I will answer this question by an illustration. Strip a strong arm, and regard the knotted muscles when the hand is clinched and the arm bent. Is this exhibition of energy the work of the muscles alone? By no means. The muscle is the channel of an influence, without which it would be as powerless as a lump of plastic dough. It is the delicate unseen nerve that unlocks the power of the muscle. And without those filaments of genius which have been shot like nerves through the body of society by the original discoverers, industrial America and industrial England would, I fear, be very much in the condition of that plastic dough. At the present time there is a cry in England for technical education, and it is the expression of a true national want; but there is no outcry for original investigation. Still without this, as surely as the stream dwindles when the spring dries, so surely will their technical education lose all force of growth, all power of reproduction. Our great investigators have given us sufficient work for a time; but if their spirit die out, we shall find ourselves eventually in the condition of those Chinese mentioned by De Tocqueville, who having forgotten the scientific origin of what they did, were at length compelled to copy without variation the inventions of an ancestry who, wiser than themselves, had drawn their inspiration direct from Nature.

To keep society as regards science in healthy play, three classes of workers are necessary: Firstly, the investigator of natural truth, whose vocation it is to pursue that truth, and extend the field of discovery for the truth's own sake, and without any reference to practical ends. Secondly, the teacher of natural truth, whose vocation it is to give public diffusion to the knowledge already won by the discoverer. Thirdly, the applier of natural truth, whose vocation it is to make scientific knowledge available for the needs, comforts and luxuries of life. These three classes ought to coexist, and interact upon each other. Now, the popular notion of science, both in this country and in England, often relates, not to science strictly so called, but to the applications of science. Such applications, especially on this continent, are so astounding—they spread themselves so largely and umbrageously before the public eye—as to shut out from view those workers who are engaged in the profounder business of discovery."

After quoting De Tocqueville on the supposed unfavorable influence which republicanism has on the advance of science, Prof. Tyndall says:—

"It rests with you to prove whether these things are necessarily so, whether the highest scientific genius cannot find in the midst of you a tranquil home. I should be loth to gainsay so keen an observer and so profound a critical writer, but since my arrival in this country, I have been unable to see anything in the constitution of society to prevent any student with the root of the matter in him from bestowing the most steadfast devotion to pure science. If great scientific results are not achieved in America, it is not to the small agitations of society that I should be disposed to ascribe the defect, but to the fact that men among you who possess the genius for scientific inquiry are laden with duties of administration or tuition so heavy as to be utterly incompatible with the continuous or tranquil meditation which original investigation demands. I do not think this state of things likely to last. I have seen in America willingness on the part of individuals to devote their fortunes in the matter of education to the service of the commonwealth, for which I cannot find a parallel elsewhere.

This willingness of private men to devote fortunes to public purposes requires but wise direction to enable you to render null and void the prediction of De Tocqueville. Your most difficult problem will be not to build institutions, but to make men; not to form the body, but to find the spiritual embers which shall kindle within that body a living soul. You have scientific genius among you; not sown broadcast, believe me, but still scattered here and there. Take all unnecessary impediments out of its way. You have asked me to give these lectures, and I cannot turn them to better account than by asking you in turn to remember that the lecturer is usually the distributor of intellectual wealth amassed by better men. It is not as lecturers, but as discoverers, that you ought to employ your highest men. Keep your sympathetic eye upon the originator of knowledge. Give him the freedom necessary for his researches, not overloading him either with the duties of tuition or of administration, not demanding from him so called practical results — above all things, avoiding that question which ignorance so often addresses to genius: What is the use of your work? Let him make truth his object, however impracticable for the time being, that truth may appear. If you cast your bread thus upon the waters, then be assured it will return to you, though it may be after many days."

Again he enforces this idea in a practical way in his dinner speech: —

"To no other country is the cultivation of science in its highest forms of more importance than to yours. In no other country would it exert a more benign and elevating influence. What, then, is to be done toward so desirable a consummation? Here I think you must take counsel of your leading scientific men, and they are

not unlikely to recommend something of this kind. I think, as regards physical science, they are likely to assure you that it is not what I may call the statical element of buildings that you require so much as the dynamical element of brains. Making use as far as possible of existing institutions, let chairs be founded, sufficiently but not luxuriously endowed, which shall have original research for their main object and ambition. With such vital centres among you, all your establishments of education would feel their influence; without such centres even your primary instruction will never flourish as it ought. I would not, as a general rule, wholly sever tuition from investigation, but, as in the institution to which I belong, the one ought to be made subservient to the other. The Royal Institution gives lectures — indeed it lives in part by lectures, though mainly by the contributions of its members, and the bequests of its friends. But the main feature of its existence — a feature never lost sight of by its wise and honorable Board of Managers — is that it is a school of research and discovery. And though a by-law gives them the power to do so, for the twenty years during which I have been there no manager or member of the institution has ever interfered with my researches. It is this wise freedom, accompanied by a never-failing sympathy, extended to the great men who preceded me, that has given to the Royal Institution its imperishable renown."

Prof. Tyndall also announced in his speech, his intention of devoting the surplus of the money received from his lectures "to the education of young philosophers in Germany." We learn from Appleton's "Popular Science Monthly," that this surplus amounted to $13,000. This sum has been conveyed, by an article of trust, to the charge of a committee, of which Prof. Joseph Henry is chairman, and which is authorized to expend the interest in aid of students who devote themselves to original researches. This is certainly, the Journal adds, a noble example, and deserves to be emulated.

The eminent French naturalist Pouchet died Dec. 6, 1872, aged 73. He was the original advocate of the theory of spontaneous generation in its modern form.

We have been obliged to defer several reviews and miscellaneous articles until the next number, and beg the indulgence of our correspondents whose articles have been unavoidably crowded out for two or three months past.

We have also an important list of "Books Received," which we shall give in the next number.

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